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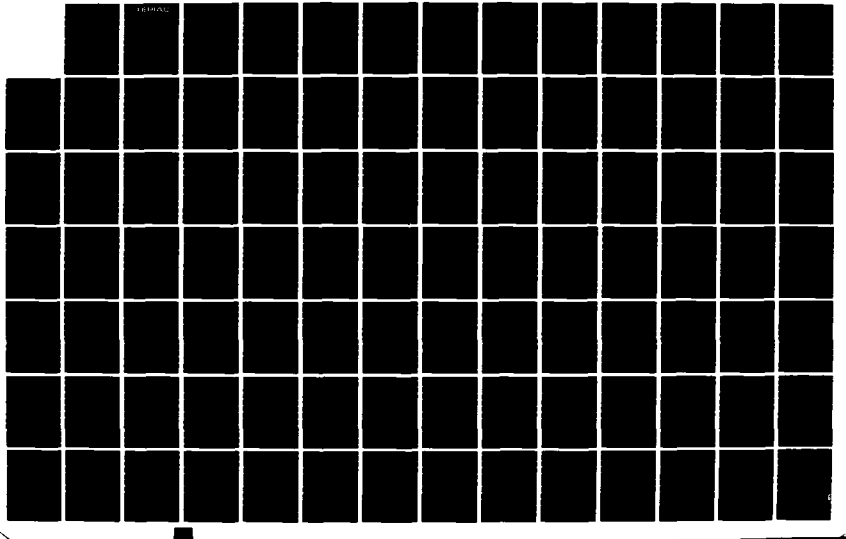

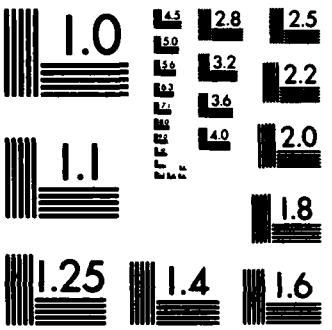

TEPIAC

A Department of Defense Information Analysis Center

SPECIFIC HEAT OF BRITISH, CZECHOSLOVAKIAN, FRENCH, GERMAN, JAPANESE, POLISH, ROMANIAN, AND SWEDISH STAINLESS STEELS

P. D. DESAI

TEPIAC/CINDAS REPORT 74

August 1983

Prepared for

DEFENSE TECHNICAL INFORMATION CENTER
Defense Logistics Agency
Alexandria, Virginia 22314

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report reviews and presents the numerical data and technical information on the specific heat of 8 British, 2 Czechoslovakian, 2 French, 20 German, 3 Japanese, 2 Polish, 1 Romanian, and 2 Swedish stainless steels. Recommended values for the specific heat of a number of these steels are also given, whenever possible. In many cases, an attempt has been made to match these steels with the equivalent steels having AISI designations.

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20. ABSTRACT (continued)

Recommendations of the specific heat values were made in many cases based on the analysis of the data for that particular stainless steel. Validity of the reported data were also checked by comparing them with the data on the equivalent AISI steels and, in a few cases, with the calculated values using the Kopp-Neumann mixing rule.

SPECIFIC HEAT OF BRITISH, CZECHOSLOVAKIAN, FRENCH, GERMAN, JAPANESE, POLISH, ROMANIAN, AND SWEDISH STAINLESS STEELS

P. D. DESAI

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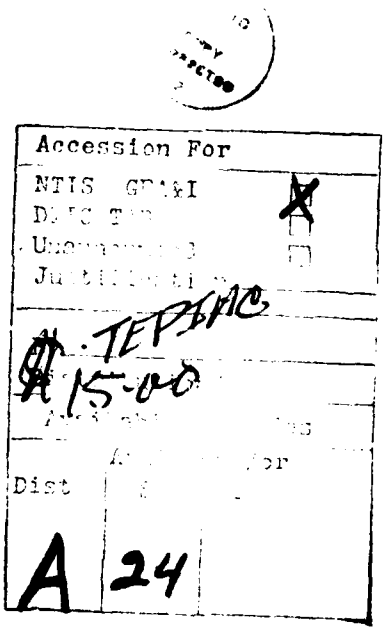

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Purdue University
2595 Yeager Road
West Lafayette, Indiana 47906

PREFACE

This State-of-the-Art Report was prepared by the Thermophysical and Electronic Properties Information Analysis Center (TEPIAC), a Department of Defense (DoD) Information Analysis Center. This Center is operated by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS), Purdue University, West Lafayette, Indiana 47906, under Defense Logistics Agency (DLA) Contract DLA900-79-C-1007. The Government Administrative Manager for TEPIAC is Mr. J.F. Pendergast, Program Manager for Information Analysis Centers, Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. TEPIAC is under the technical direction of the Army Materials and Mechanics Research Center (AMMRC), Watertown, Massachusetts 02172, with Mr. David W. Seitz as the Contracting Officer's Technical Representative. The Contract was issued by the Defense Electronics Supply Center, Dayton, Ohio, with Ms. Sara M. Williams as the Contracting Officer.

This report presents the numerical data and technical information on the specific heat of British, Czechoslovakian, French, German, Japanese, Polish, Romanian, and Swedish stainless steels and constitutes a valuable source of data and information for engineers and scientists in the DoD community who have a need for such data and information in their evaluation and studies programs on foreign-made weapons, equipment, instruments, etc. This work should also be useful to other engineers and scientists working on various programs who have a need for information on these stainless steels.

As TEPIAC maintains in-depth cognizance of the world literature on materials properties on a continuing basis, new data and information on these stainless steels, when available, are constantly being added to the TEPIAC file.

The author wishes to acknowledge the valuable assistance of Ms. Diane M. Coffing in organizing and typing this report.

West Lafayette, Indiana
August 1983

C. Y. Ho
Director, TEPIAC/CINDAS
Purdue University

ABSTRACT

This report reviews and presents the numerical data and technical information on the specific heat of 8 British, 2 Czechoslovakian, 2 French, 20 German, 3 Japanese, 2 Polish, 1 Romanian, and 2 Swedish stainless steels. Recommended values for the specific heat of a number of these steels are also given, whenever possible. In many cases, an attempt has been made to match these steels with the equivalent steels having AISI designations.

Recommendations of the specific heat values were made in many cases based on the analysis of the data for that particular stainless steel. Validity of the reported data were also checked by comparing them with the data on the equivalent AISI steels and, in a few cases, with the calculated values using the Kopp-Neumann mixing rule.

Key Words: Specific heat, stainless steels, thermodynamic property, British stainless steels, Czechoslovakian stainless steels, French stainless steels, German stainless steels, Japanese stainless steels, Polish stainless steels, Romanian stainless steels, Swedish stainless steels, AISI equivalent stainless steels.

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1. INTRODUCTION

The principal objective of this report on the 'Specific Heat of British, Czechoslovakian, French, German, Japanese, Polish, Romanian, and Swedish Stainless Steels' is to provide engineers, metallurgists, and scientists easy access to the numerical data and technical information on the specific heat of these stainless steels. It also provides a key to quickly establish the chemical composition of a large number of stainless steels commonly used in these eight countries as well as their AISI equivalents.

Data and information on these stainless steels are published constantly. This report represents the first attempt of its kind to present the data and information on the specific heat of technologically important foreign stainless steels available in the open literature. Information and numerical data on the Soviet stainless steels has been published in TEPIAC/CINDAS Report 67.

The search for the specific heat of these stainless steels (with Cr $\geq$ 12%) uncovered the data for many steels. During the course of this investigation, it was observed that many of these steels are compositionally nearly equivalent to many U.S. stainless steels.

The stainless steels covered in this report are identified by their standardized designations where available, otherwise by the common name. For instance, British stainless steels are designated by those established by the British Standard Institute (BS); French stainless steels by the Association Francaise de Normalisation (AFNOR), West German steels by the Deutsches Institut fur Normung (DIN), and so on. The listing of the stainless steels appearing in this report is arranged in an alphabetic ordering of the designation. In many cases, an attempt has been made not only to match other designations with the standardized designations, but also to match them with AISI stainless steel designations. This type of comparison is most useful to derive specific heat values for a number of technologicaly important stainless steels for which experimental data are not available.

In Chapter 2, data and information for each of the stainless steels, organized using the above procedure, is presented in a self-contained section which includes a brief description of the steel, a technical discussion on the

specific heat, tabular specific heat values followed by reference(s) and figures containing experimental data and the recommended/tabulated specific heat values.

The specific heat data for the stainless steels included in this report typically comprise one or two data sets. It is, therefore, an imperative task to critically evaluate and analyze the available data. The procedure involves critical evaluation of the validity and the reliability of the data and the related information, resolution and reconciliation of disagreements in conflicting data, correlation of data in terms of various controlling parameters, and comparison of results with the theoretical predictions or with reliable data for known equivalent stainless steels. These methods were used to derive the recommended values which are internally consistent and cover a wide range of temperature.

The technical terms, symbols, and units used in this report are defined below:

c_p specific heat, in J $kg^{-1}K^{-1}$

T temperature, in K

2. BRITISH STAINLESS STEELS

2.1. En 56B STAINLESS STEEL

The nominal composition of En 56B stainless steel is 12.0-14.0% Cr, 1.0%(max) Ni, 1.00%(max) Mn, 1.00%(max) Si, 0.12%(max) C, 0.045%(max) P, 0.045%(max) S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 420 stainless steel [1]. En 56B stainless steel is considered the composition equivalent of AISI 420. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.1. RECOMMENDED SPECIFIC HEAT OF En 56B STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	446	1100	781
300	449	1120	833
350	472	1150	965
400	492	1160	671
500	533	1180	640
600	577	1200	635
700	636	1300	646
800	708	1400	665
900	818	1500	688
950	929		
980	1210		
1000	900		
1020	800		
1050	754		
1070	745		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

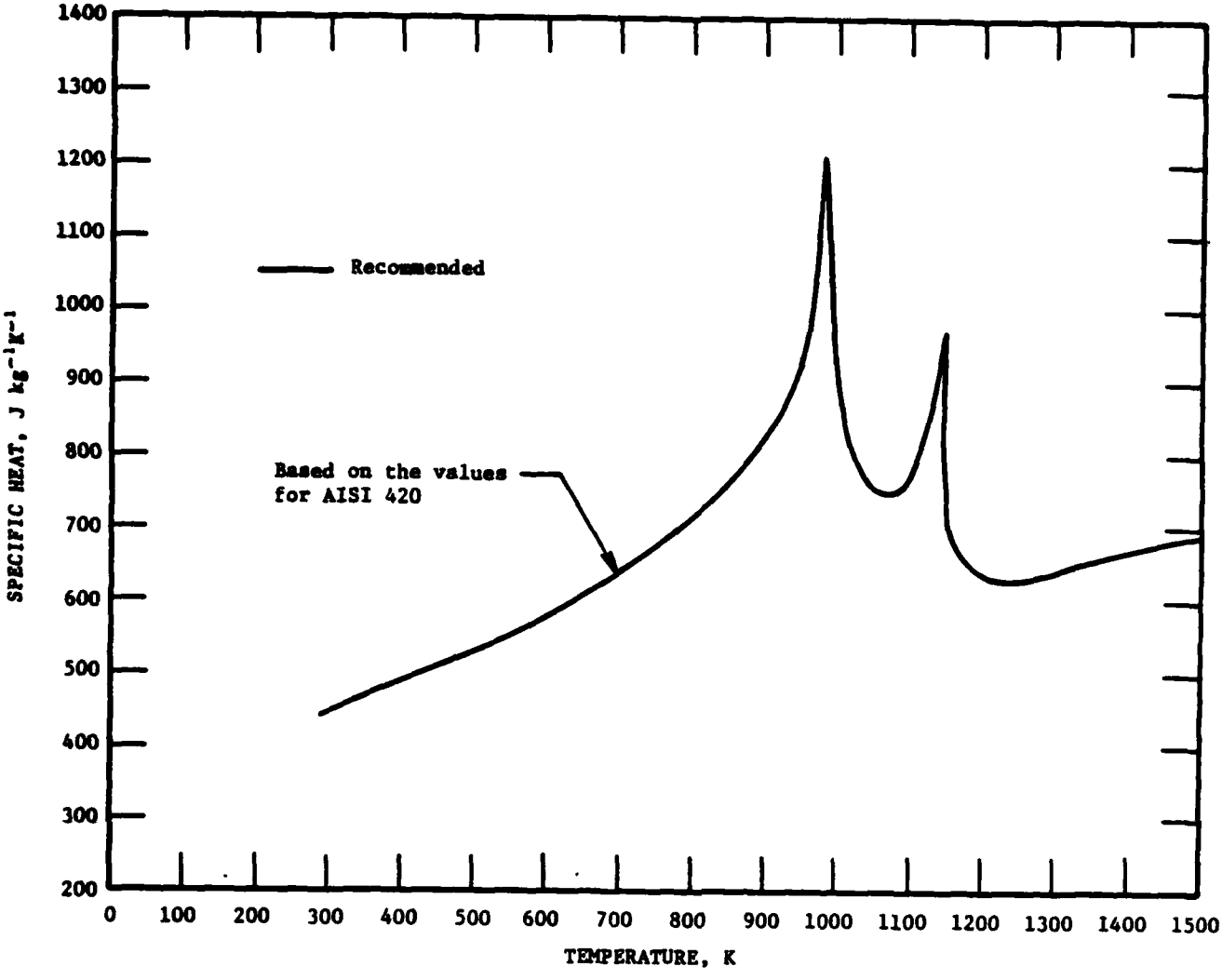

FIGURE 2.1. SPECIFIC HEAT OF En 56B STAINLESS STEEL.

2.2. En 58B STAINLESS STEEL

The nominal composition of En 58B stainless steel is 17.0–20.0% Cr, 7.0–10.0% Ni, 2.00%(max) Mn, 0.20%(min) Si, 0.15%(max) C, 0.045%(max) P, 0.045%(max) S, 4XC%(min) Ti, and balance Fe. There is only one experimental data set available for the specific heat of En 58B stainless steel covering the temperature range 60–320 K [1]. The recommended values for the specific heat are based on the data of Martin [1] and also on those recommended for AISI 321 stainless steel [2]. En 58B stainless steel is considered the composition equivalent of AISI 321. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.2. RECOMMENDED SPECIFIC HEAT OF En 58B STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
50	79.0	500	527
60	120	600	547
70	160	700	563
80	195	800	574
90	230	900	586
100	258	1000	601
150	361	1100	617
200	415	1200	633
250	448	1300	651
273	461	1400	669
293	469		
300	472		
350	489		
400	504		
450	516		

REFERENCES

1. Martin, J.F., J. Iron Steel Inst. (London), 204(1), 56, 1966.

2. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

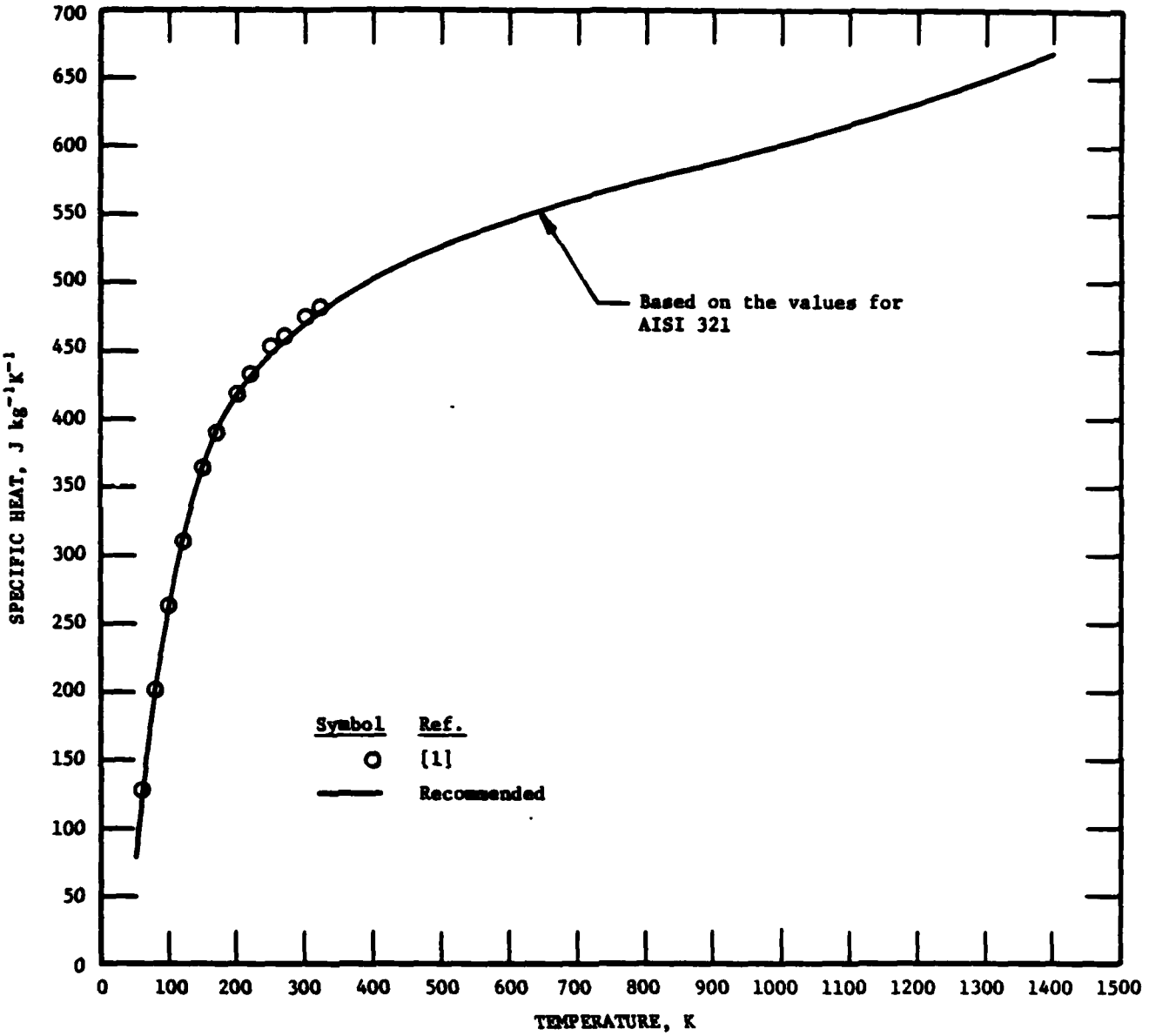

FIGURE 2.2. SPECIFIC HEAT OF En 58B STAINLESS STEEL.

2.3. En 58C STAINLESS STEEL

The nominal composition of En 58C stainless steel is 17.0–20.0% Cr, 9.0–12.0% Ni, 2.00%(max) Mn, 0.20%(min) Si, 0.15%(max) C, 0.045%(max) P, 0.045%(max) S, 4 x C%(min) Ti, and balance Fe. The recommended values for the specific heat of En 58C stainless steel are based on the low-temperature data of Martin [1] and the values for its equivalent, AISI 321 stainless steel [2]. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.3. RECOMMENDED SPECIFIC HEAT OF En 58C STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
50	79.0	500	527
60	120	600	547
70	160	700	563
80	195	800	574
90	230	900	586
100	258	1000	601
150	361	1100	617
200	415	1200	633
250	448	1300	651
273	461	1400	669
293	469		
300	472		
350	489		
400	504		
450	516		

REFERENCES

1. Martin, J.F., J. Iron Steel Inst. (London), 204(1), 56, 1966.

2. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

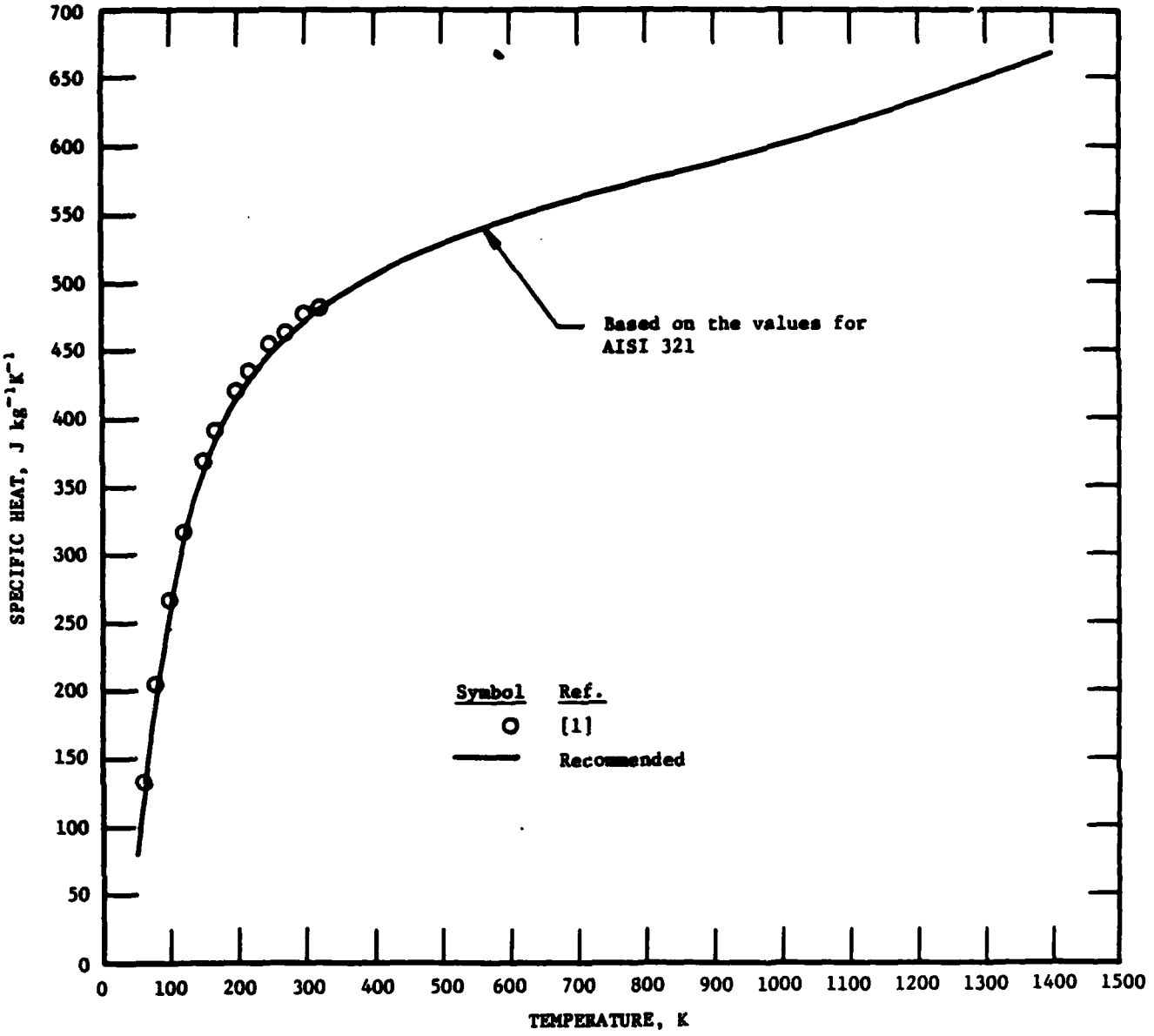

FIGURE 2.3. SPECIFIC HEAT OF En 58C STAINLESS STEEL.

2.4. En 58E STAINLESS STEEL

The nominal composition of En 58E stainless steel is 17.5–20.0% Cr, 8.0–11.0% Ni, 2.00%(max) Mn, 0.20%(min) Si, 0.08%(max) C, 0.045%(max) P, 0.045%(max) S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 304 stainless steel [1]. En 58E stainless steel is considered the composition equivalent of AISI 304. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.4. RECOMMENDED SPECIFIC HEAT OF En 58E STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481	1600	704
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

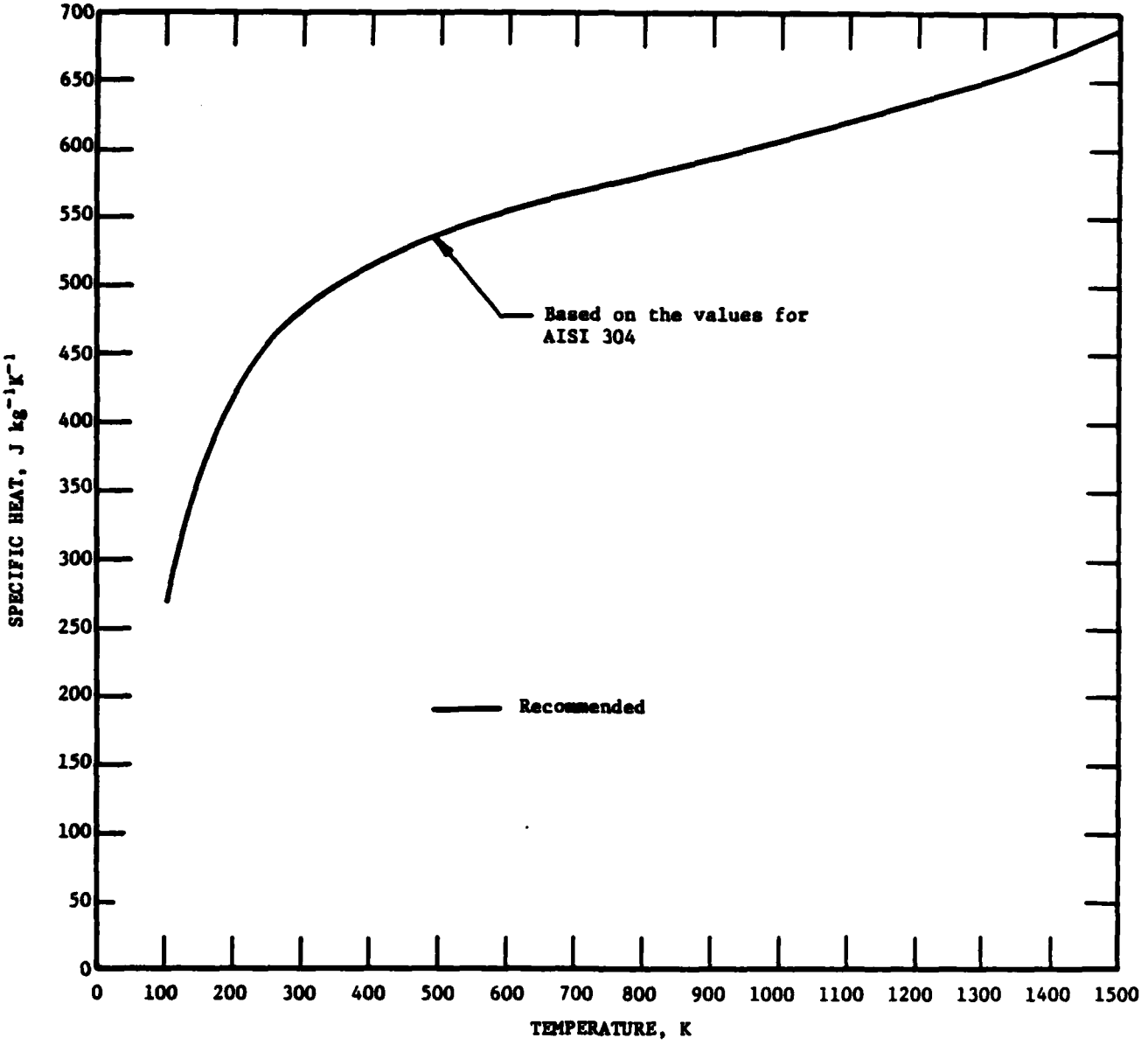

FIGURE 2.4. SPECIFIC HEAT OF En 58E STAINLESS STEEL.

2.5. FCBC STAINLESS STEEL

The composition of FCBC stainless steel is 18.68% Cr, 8.85% Ni, 1.23% Mn, 0.62% Si, 0.08% C, 0.99% Nb, 0.14% Ti, and balance Fe. There are no experimental data sets available for the specific heat of this stainless steel. The recommended values for the specific heat are based on those recommended for AISI 347 stainless steel [1]. FCBC stainless steel is considered the composition equivalent of AISI 347. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.5. RECOMMENDED SPECIFIC HEAT OF FCBC STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	462	1000	608
300	464	1100	629
350	479	1200	650
400	492	1300	672
450	503	1400	694
500	513	1500	718
600	532		
700	549		
800	568		
900	588		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

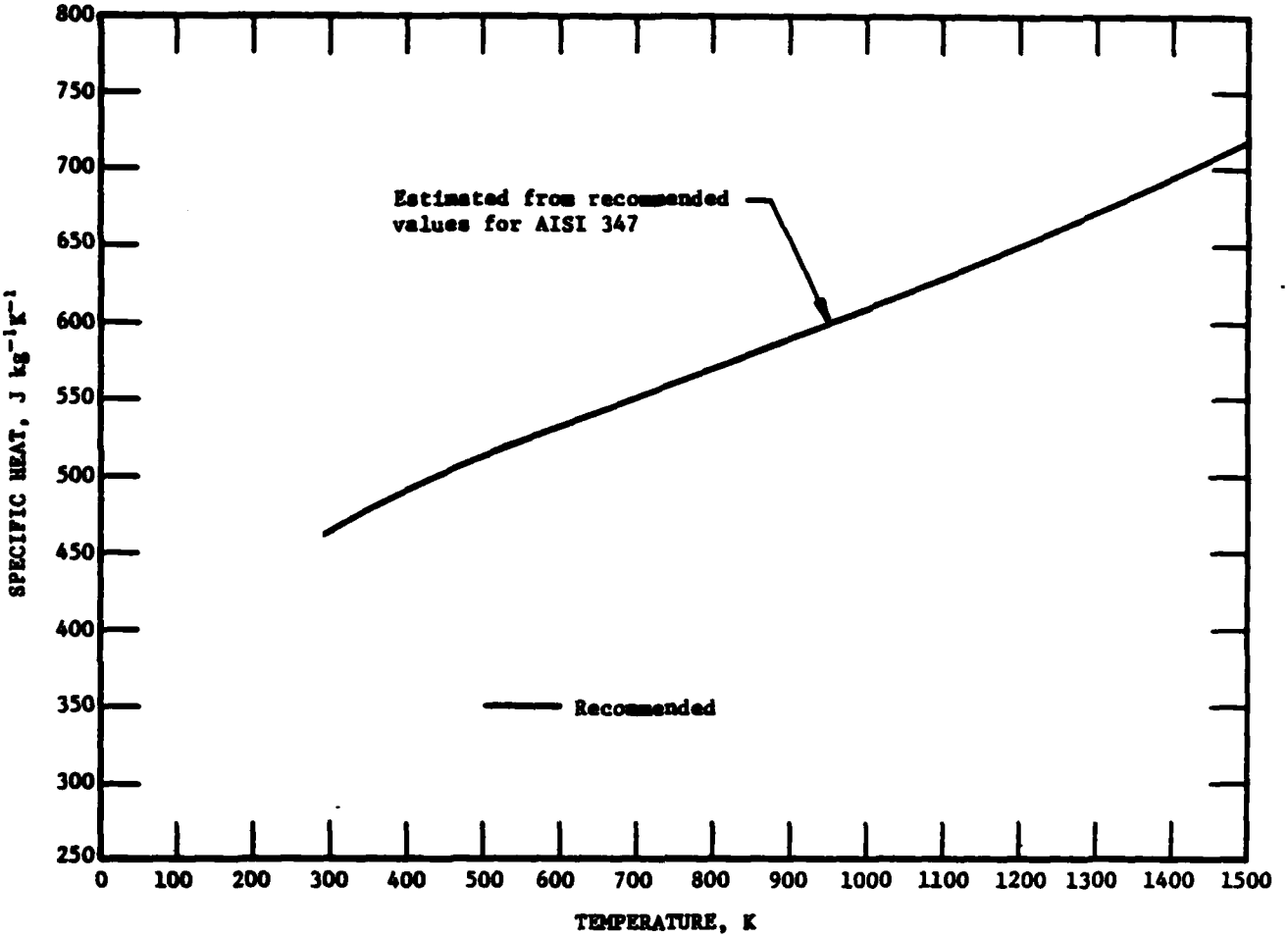

FIGURE 2.5. SPECIFIC HEAT OF FCBC STAINLESS STEEL.

2.6. FH STAINLESS STEEL

The composition of FH stainless steel is 13.65% Cr, 0.37% Ni, 0.29% Mn, 0.27% Si, 0.27% C, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 420 stainless steel [1] whose composition is somewhat similar to this British steel. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.6. RECOMMENDED SPECIFIC HEAT OF FH STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	446	1100	781
300	449	1120	833
350	472	1150	965
400	492	1160	671
500	533	1180	640
600	577	1200	635
700	636	1300	646
800	708	1400	665
900	818	1500	688
950	929		
980	1210		
1000	900		
1020	800		
1050	754		
1070	745		

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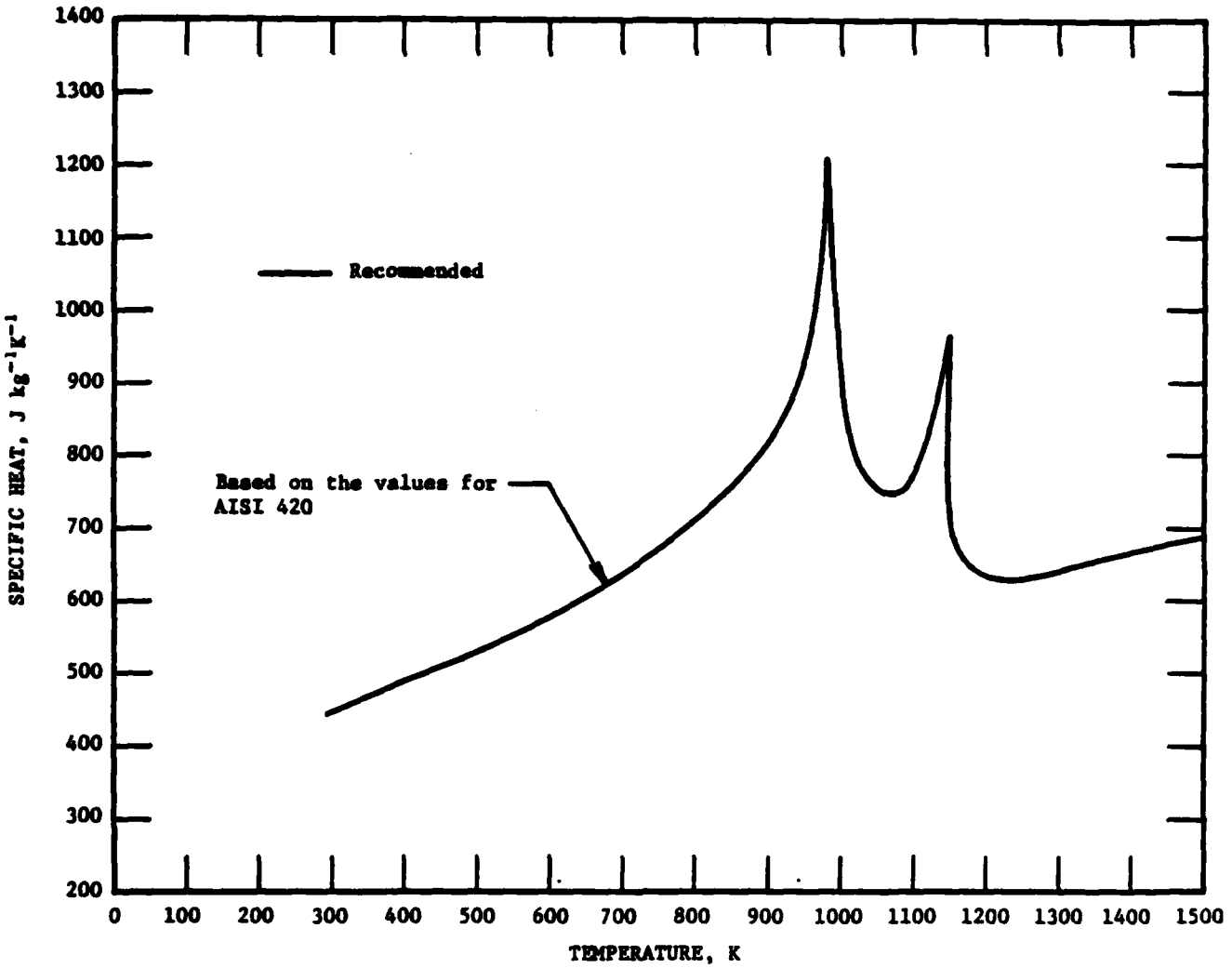

FIGURE 2.6. SPECIFIC HEAT OF FH STAINLESS STEEL.

2.7. FI 17 STAINLESS STEEL

The composition of this steel is 17.0% Cr, 0.87% Mn, 0.07% C, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 430 stainless steel [1] whose composition is somewhat similar to that of FI 17 stainless steel. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.7. RECOMMENDED SPECIFIC HEAT OF FI 17 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	212	900	921
150	322	950	1088
200	384	1000	880
250	428	1050	758
273	440	1100	706
293	451	1200	665
300	455	1300	665
350	497	1400	682
400	497	1500	710
450	517		
500	538		
600	585		
700	644		
800	730		
850	802		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

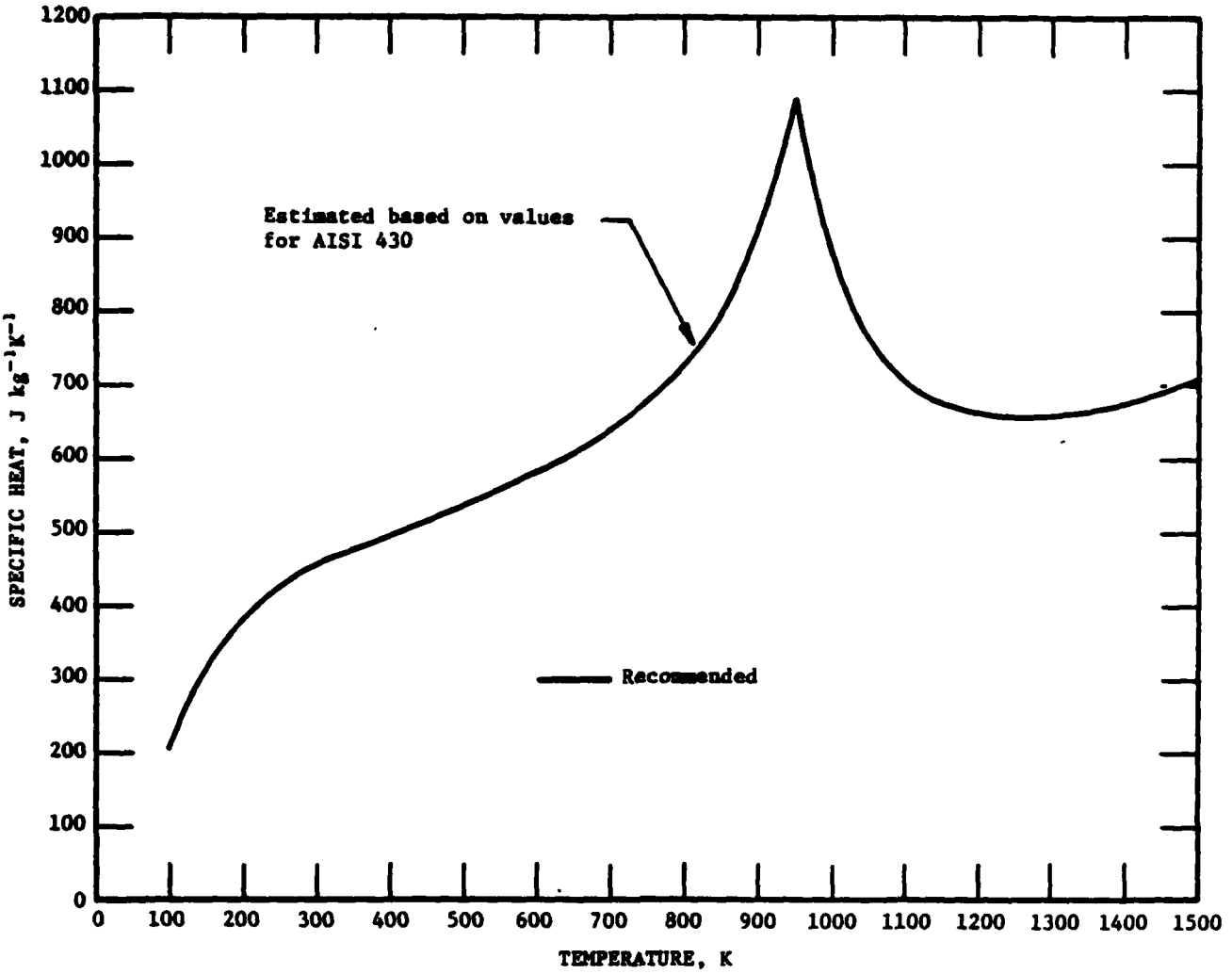

FIGURE 2.7. SPECIFIC HEAT OF FI 17 STAINLESS STEEL.

2.8. STAYBRITE STAINLESS STEEL

The composition of Staybrite stainless steel of type 18/8 is 17.87% Cr, 8.04% Ni, 0.26% Mn, 0.19% Si, 0.15% C, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 304 stainless steel [1]. The composition of Staybrite stainless steel is somewhat similar to that of AISI 304. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 2.8. RECOMMENDED SPECIFIC HEAT OF STAYBRITE STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481	1600	704
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

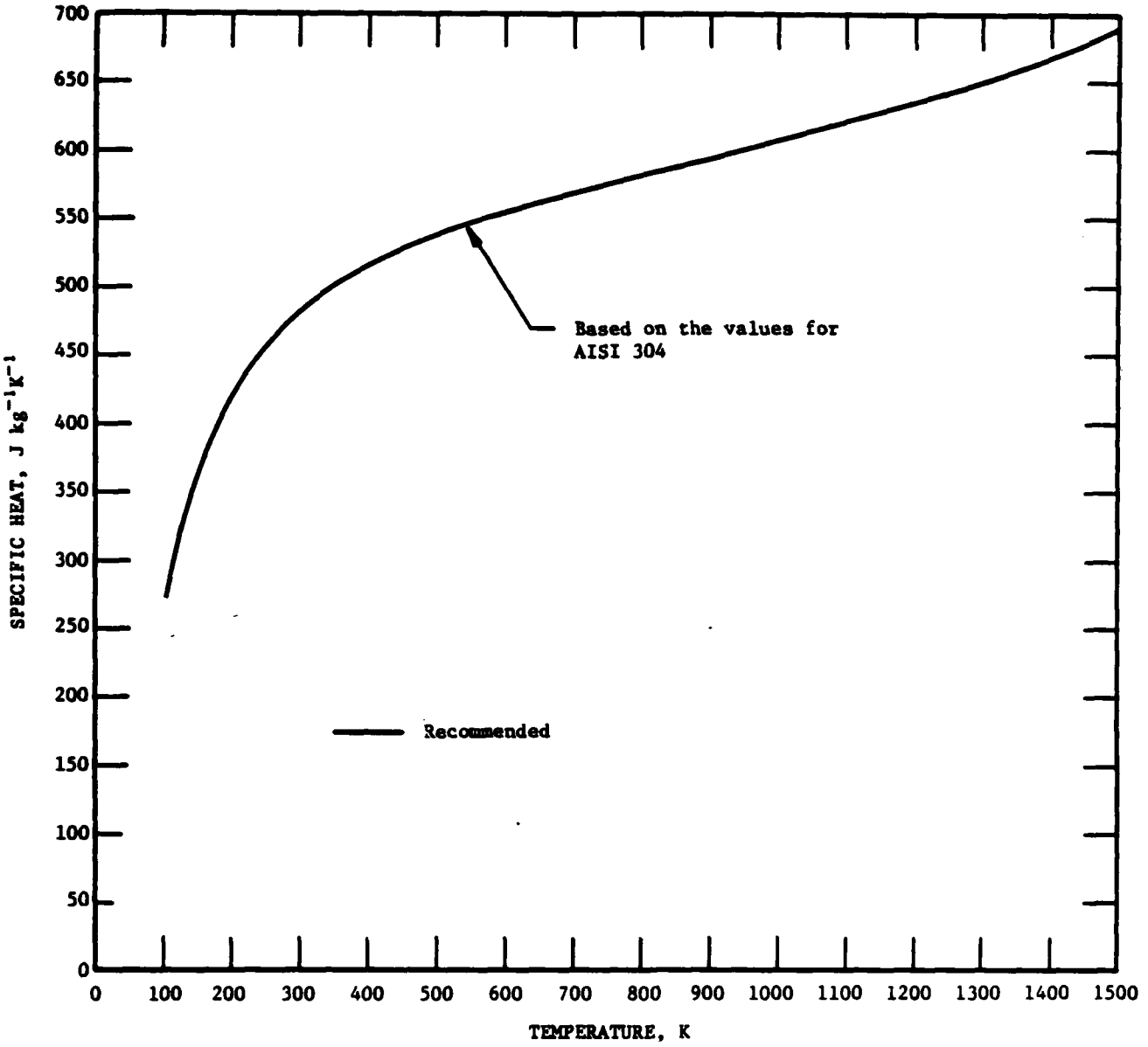

FIGURE 2.8. SPECIFIC HEAT OF STAYBRITE STAINLESS STEEL.

3. CZECHOSLOVAKIAN STAINLESS STEELS

3.1. 17242 STAINLESS STEEL

The composition of 17242 stainless steel is 16.0% Cr, 10.0% Ni, 0.2% C, and balance Fe. The values for the specific heat of this stainless steel are based on the data of Malek et al. [1] who cover the range below room temperature. The values above 245 K are based on the values for its equivalent, AISI 302 stainless steel. The uncertainty in the specific heat values is about ±5%.

TABLE 3.1. RECOMMENDED SPECIFIC HEAT OF 17242 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
4	1.89	150	372
7	3.38	200	438
10	5.04	250	472
15	8.13	273	482
20	13.1	293	489
25	20.8	300	491
30	30.9	350	506
35	42.9	400	518
40	55.9	450	528
50	91.0	500	538
60	132	600	554
70	172	700	569
80	208	800	581
90	240	900	595
100	268	1000	609

REFERENCE

1. Malek, Z., Bischot, J., Molokac, S., Novotny, V., and Ryska, A., Electrotech. Obz. (Czechoslovakia), 66(2), 98-103, 1977.

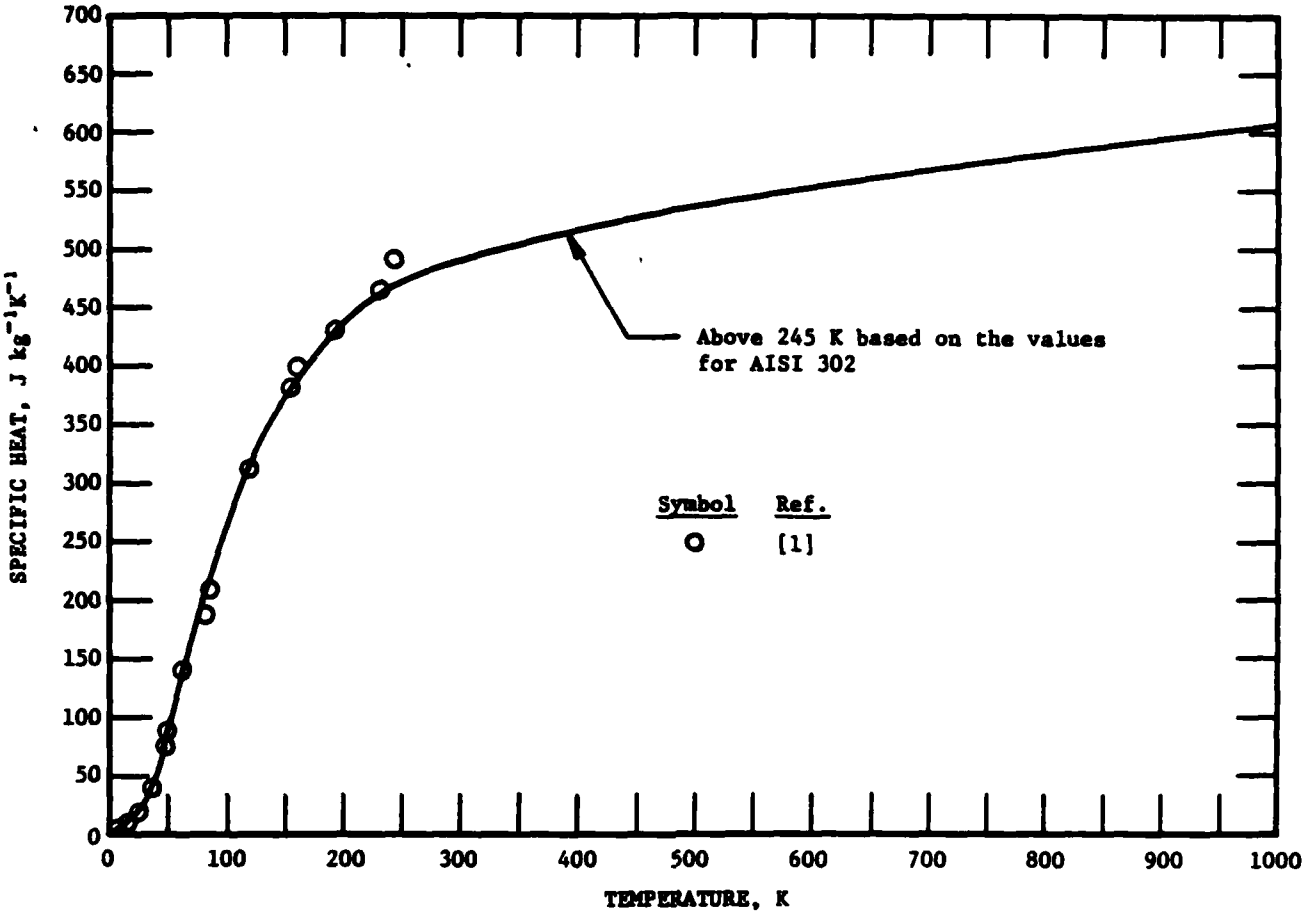

FIGURE 3.1. SPECIFIC HEAT OF 17242 STAINLESS STEEL.

3.2. 17246 STAINLESS STEEL

The composition of 17246 stainless steel is 19.0% Cr, 10.0% Ni, 0.5% Ti, 0.1% C, and balance Fe. The values for the specific heat of this stainless steel is based on the data of Malek et al. [1] who report the data below room temperature only. The specific heat values above room temperature are based on the values recommended for its equivalent, AISI 321 stainless steel. The uncertainty in the tabulated specific heat values is about ±8%.

TABLE 3.2. RECOMMENDED SPECIFIC HEAT OF 17246 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
2	1.01	150	400
4	2.04	200	452
7	3.70	250	478
10	5.40	273	487
15	9.87	293	492
20	11.8	300	494
25	16.2	350	504
30	24.5	400	513
40	48.0	450	522
50	79.0	500	531
60	120	600	547
70	170	700	563
80	222	800	574
90	264	900	586
100	298	1000	601

REFERENCE

1. Malek, Z., Bischot, J., Molokac, S., Novotny, V., and Ryska, A., Electrotech. Obz. (Czechoslovakia), 66(2), 98-103, 1977.

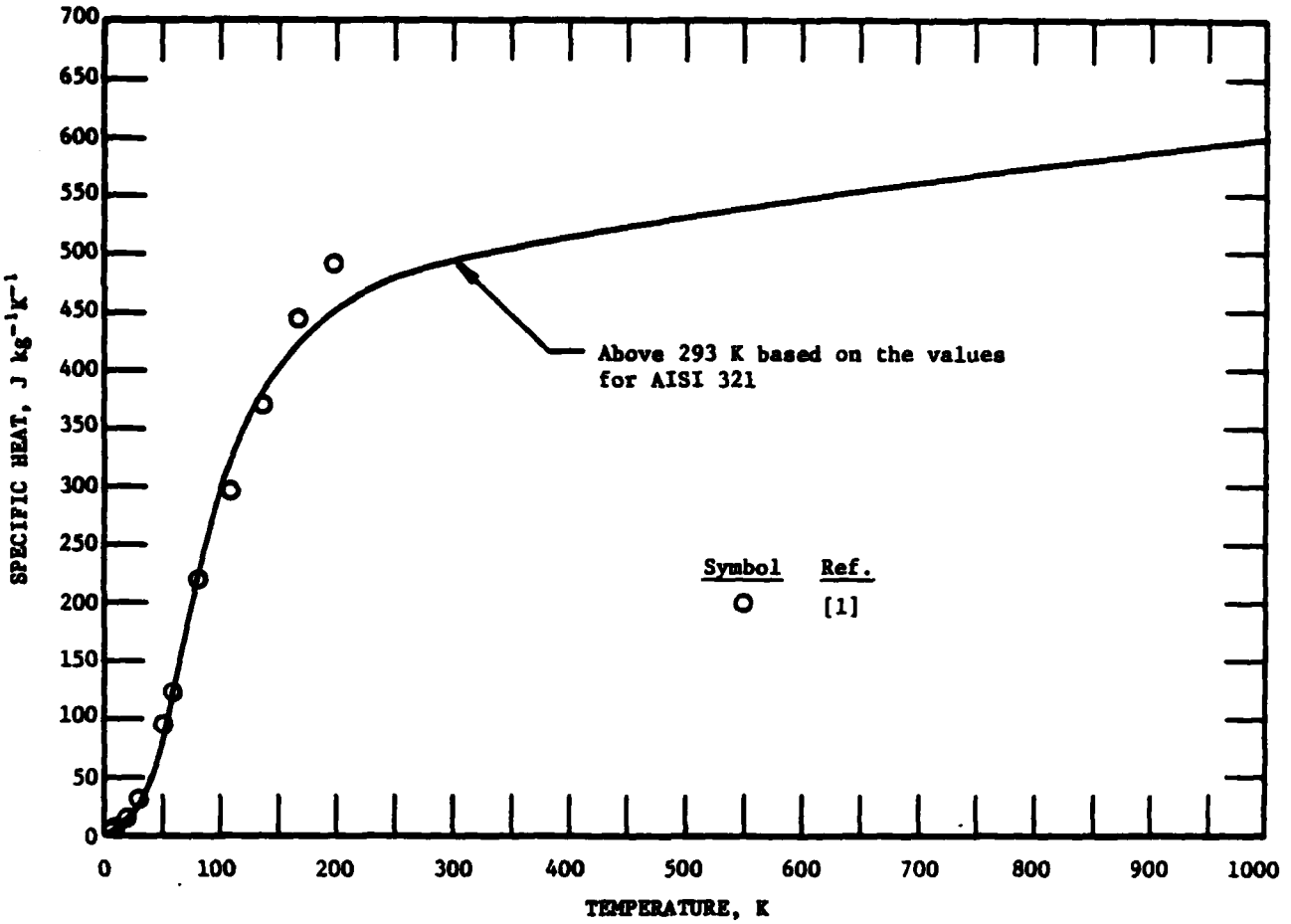

FIGURE 3.2. SPECIFIC HEAT OF 17246 STAINLESS STEEL.

4. FRENCH STAINLESS STEELS

4.1. Z3 CN 18.10 STAINLESS STEEL [NS 22 S]

The French Z 3 CN 18.10 stainless steel is a low-carbon version of the basic 18/8-type of austenitic stainless steel. The nominal composition is: 0.04% (max) C, 2.0% (max) Mn, 1.0% (max) Si, 0.040% (max) P, 0.030% (max) S, 17.0-20.0% Cr, 9.0-12.0% Ni, and balance Fe.

A stainless steel with overlapping composition ranges is AISI 304L steel [0.03% (max) C, 2.00% (max) Mn, 1.00% (max) Si, 0.045% (max) P, 0.030% (max) S, 18.00-20.00% Cr, 8.00-12.00% Ni, and balance Fe]. It is expected, therefore, that the specific heat for these two stainless steels will likewise be the same.

The recommended values for the specific heat of Z 3 CN 18.10 stainless steel in the annealed condition are based on those recommended for AISI 304 stainless steel [1]. The uncertainty is estimated to be within ±5%.

TABLE 4.1. RECOMMENDED SPECIFIC HEAT OF Z 3 CN 18.10 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481	1600	704
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

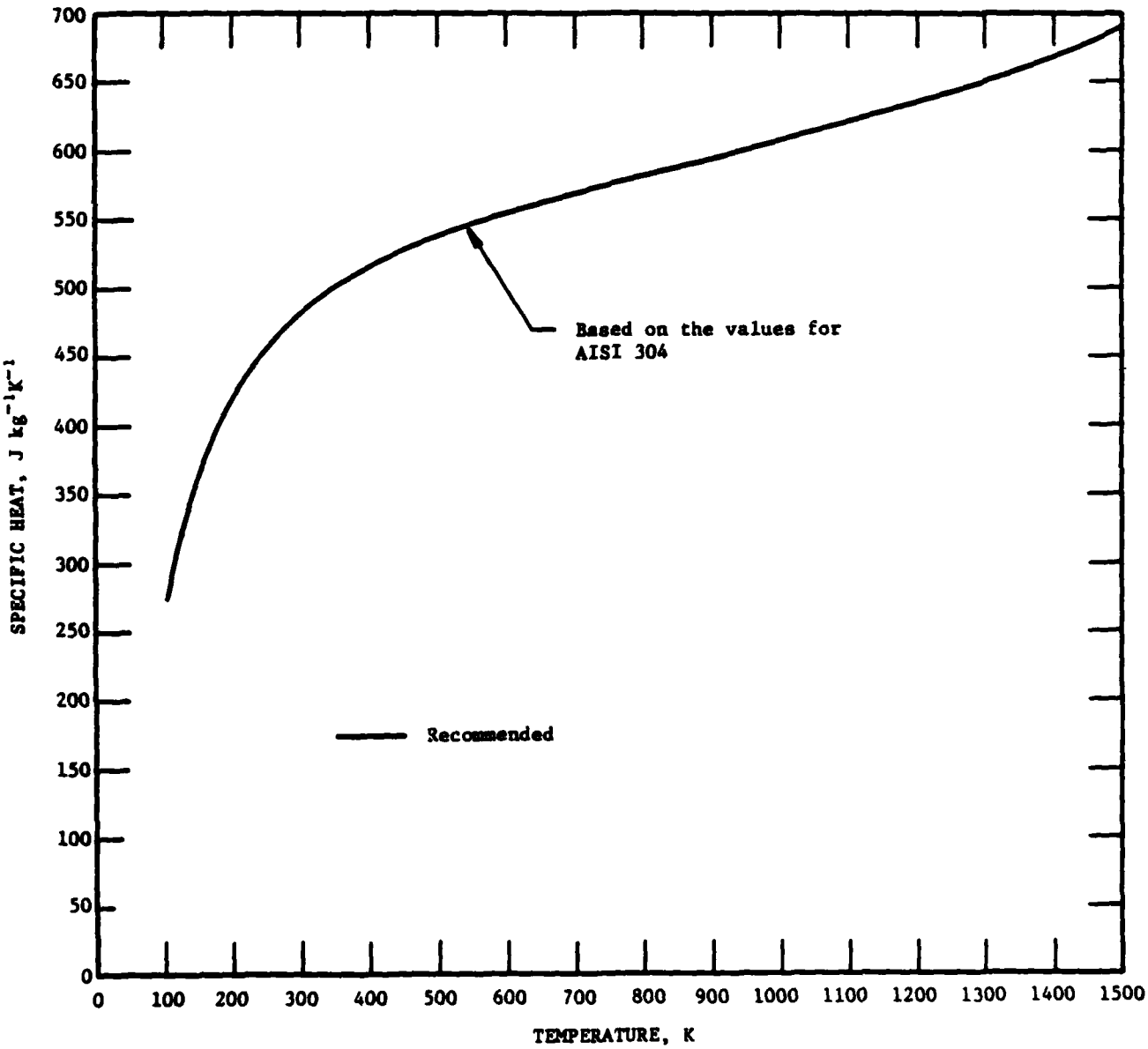

FIGURE 4.1. SPECIFIC HEAT OF Z 3 CN 18.10 STAINLESS STEEL.

4.2. Z 5 NCTDV 25 STAINLESS STEEL

The French Z 5 NCTDV 25 stainless steel is an age-hardenable, high nickel-chromium, austenitic stainless steel. The nominal composition is: 0.08% (max) C, 1.00–2.00% Mn, 0.40–1.00% Si, 13.5–16.0% Cr, 24.0–27.0% Ni, 1.00–1.50% Mo, 1.90–2.30% Ti, 0.35% (max) Al, 0.10–0.50% V, and balance Fe. The heat-treatment sequence for this steel includes a solution-anneal at about 1273 K with air or water quench, followed by an age at 973 K. Aging promotes formation of a γ' [$Ni_3(Ti,Al)$] precipitate within the austenite matrix. The aged material exhibits typical strengths of 1030 MPa tensile and 690 MPa yield. This steel is used primarily for high temperature service to about 950 K, finding application to turbine engine components.

A stainless steel having the same composition ranges except for boron is AISI 660 stainless steel [0.08% (max) C, 1.0–2.0% Mn, 0.4–1.0% Si, 0.040% (max) P, 0.030% (max) S, 13.5–16.0% Cr, 24.0–27.0% Ni, 1.0–1.5% Mo, 1.9–2.3% Ti, 0.35% (max) Al, 0.10–0.50% V, 0.003–0.010% B, and balance Fe]. Since both composition and heat-treatment sequence for these two steels are so similar, it is expected that the specific heat is likewise essentially the same.

The recommended values for the specific heat of Z 5 NCTDV 25 stainless steel are based on those recommended for AISI 660 stainless steel [1]. The uncertainty is estimated to be within ±5%.

TABLE 4.2. RECOMMENDED SPECIFIC HEAT OF Z 5 NCTDV 25 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
200	374	700	578
250	436	800	598
273	455	850	618
293	468	900	648
300	472	950	678
350	494		
400	511		
450	525		
500	537		
600	559		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

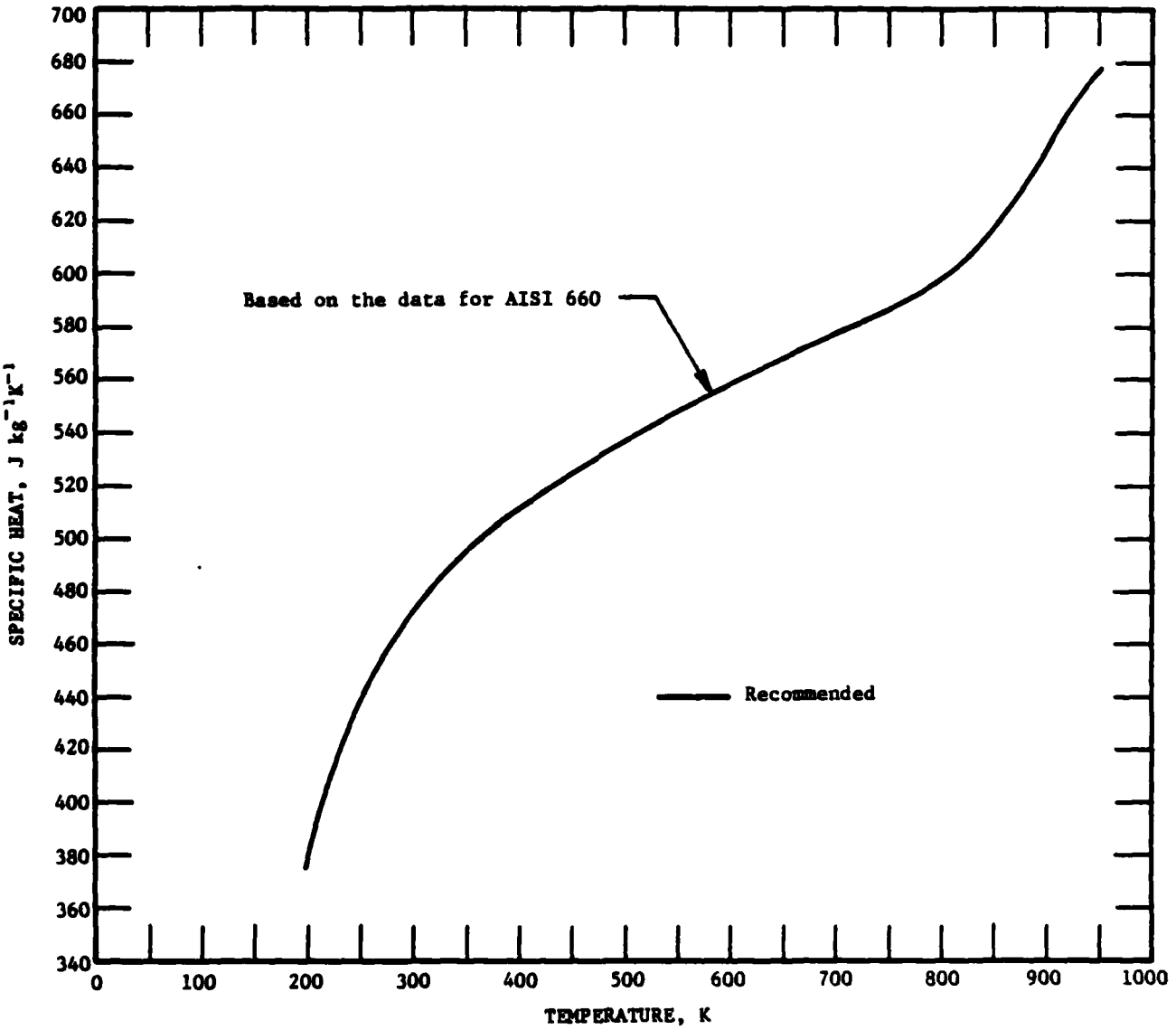

FIGURE 4.2. SPECIFIC HEAT OF Z 5 NCTDV 25 STAINLESS STEEL.

5. GERMAN STAINLESS STEELS

5.1. X 2 CrNiMo 18 10 STAINLESS STEEL [DIN 1.4402]

The nominal composition of X 2 CrNiMo 18 10 stainless steel is 16.5–18.5% Cr, 11.0–14.0% Ni, $\leq$0.03% C, $\leq$2.0% Mn, $\leq$1.0% Si, 2.0–2.5% Mo, 0.045% P, 0.030% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 316 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.1. RECOMMENDED SPECIFIC HEAT OF X 2 CrNiMo 18 10 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	442	1000	602
300	444	1100	621
350	463	1200	639
400	480	1300	657
450	496	1400	675
500	509	1500	694
600	532		
700	550		
800	567		
900	584		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

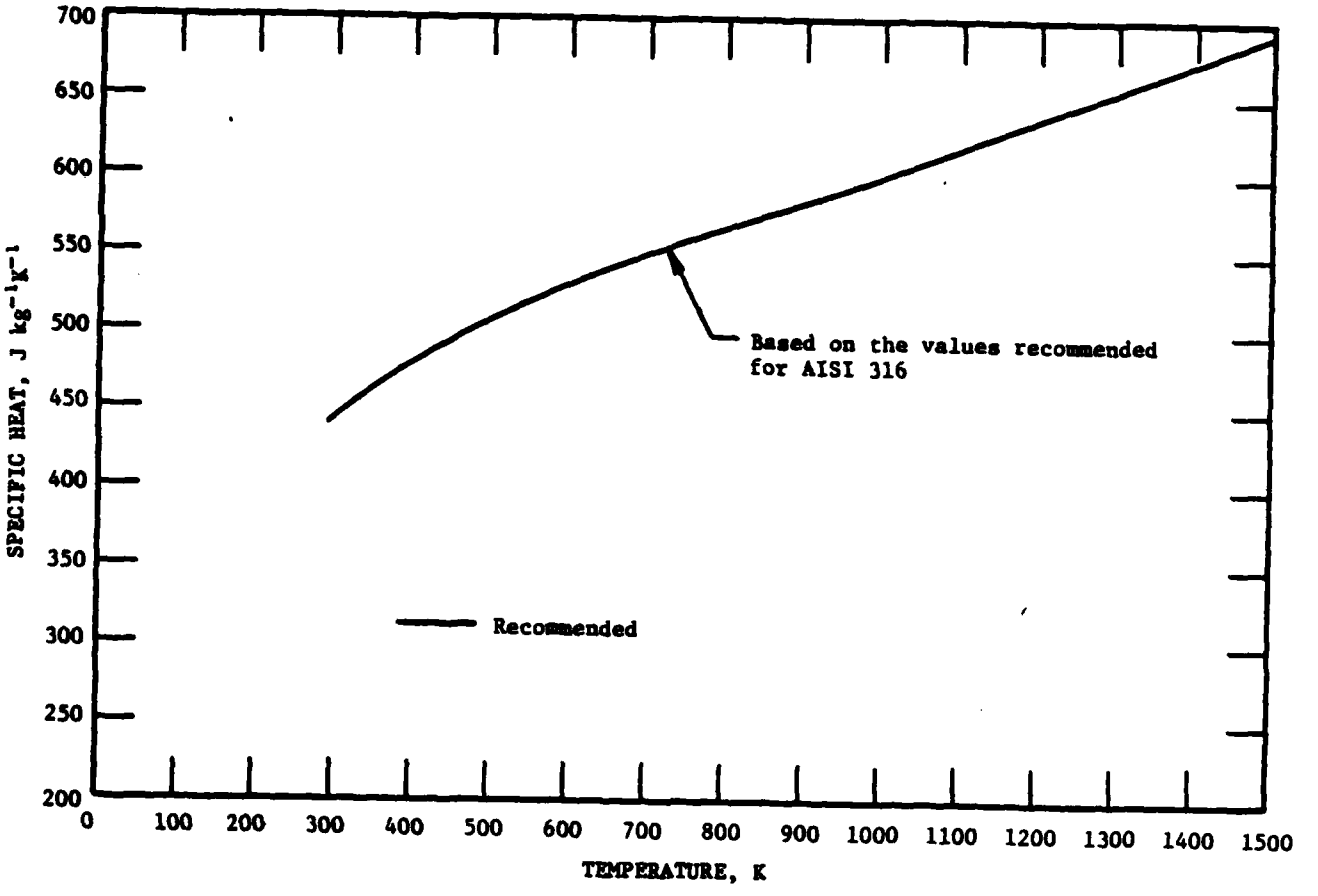

FIGURE 5.1. SPECIFIC HEAT OF X 2 CrNiMo 18 10 STAINLESS STEEL.

5.2. X 5 CrNi 18 9 STAINLESS STEEL [DIN 1.4301]

The nominal composition of X 5 CrNi 18 9 stainless steel is 17.0–20.0% Cr, 8.5–10.0% Ni, $\leq$0.07% C, $\leq$2.0% Mn, $\leq$1.0% Si, 0.045% P, 0.02% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 304 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.2. RECOMMENDED SPECIFIC HEAT OF X 5 CrNi 18 9 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481	1600	704
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

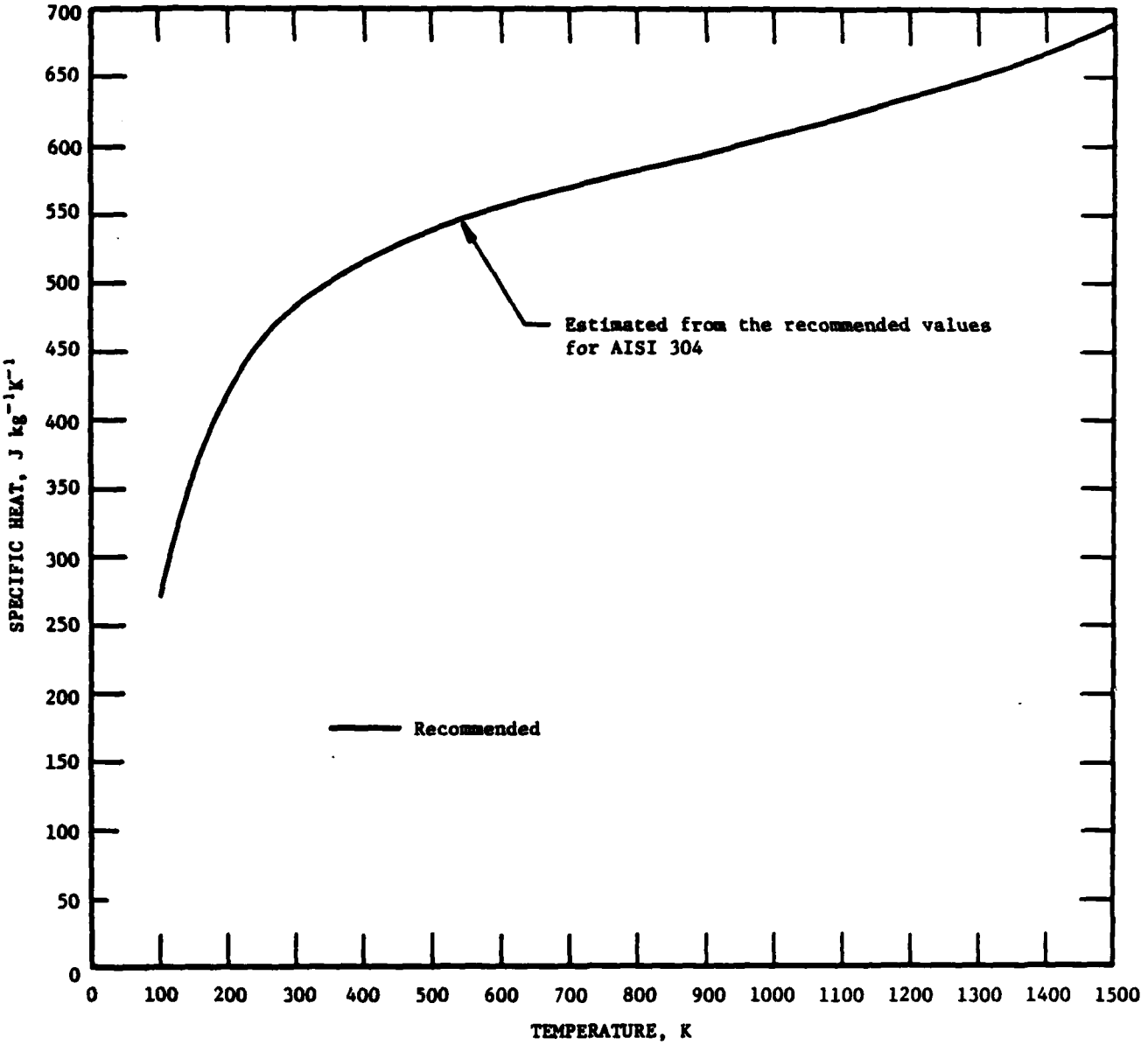

FIGURE 5.2. SPECIFIC HEAT OF X 5 CrNi 18 9 STAINLESS STEEL.

5.3. X 6 CrNiWNb 16 16 STAINLESS STEEL (ATS 26) [DIN 1.4945]

The nominal composition of X 6 CrNiWNb 16 16 stainless steel is 15.5-17.5% Cr, 15.5-17.5% Ni, 2.5-3.5% W, 0.04-0.10% C, $\leq$1.5% Mn, 0.30-0.60% Si, >10xC% (Nb+Ta), 0.03% S, 0.03% P, and balance Fe. The values for the specific heat of this steel are taken from the data of Preisendanz et al. [1]. The values from the Kopp-Neumann mixing rule are up to 6% higher above 500 K and below that the values are up to 4% lower than those from Ref. [1].

TABLE 5.3. RECOMMENDED SPECIFIC HEAT OF X 6 CrNiWNb 16 16 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	484	1000	462
300	485	1050	566
350	487	1100	569
400	489	1150	572
450	492	1200	575
500	495	1250	577
550	498	1300	578
600	502		
650	508		
700	514		
750	521		
800	530		
850	540		
900	549		
950	556		

REFERENCE

1. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293-300, 1969.

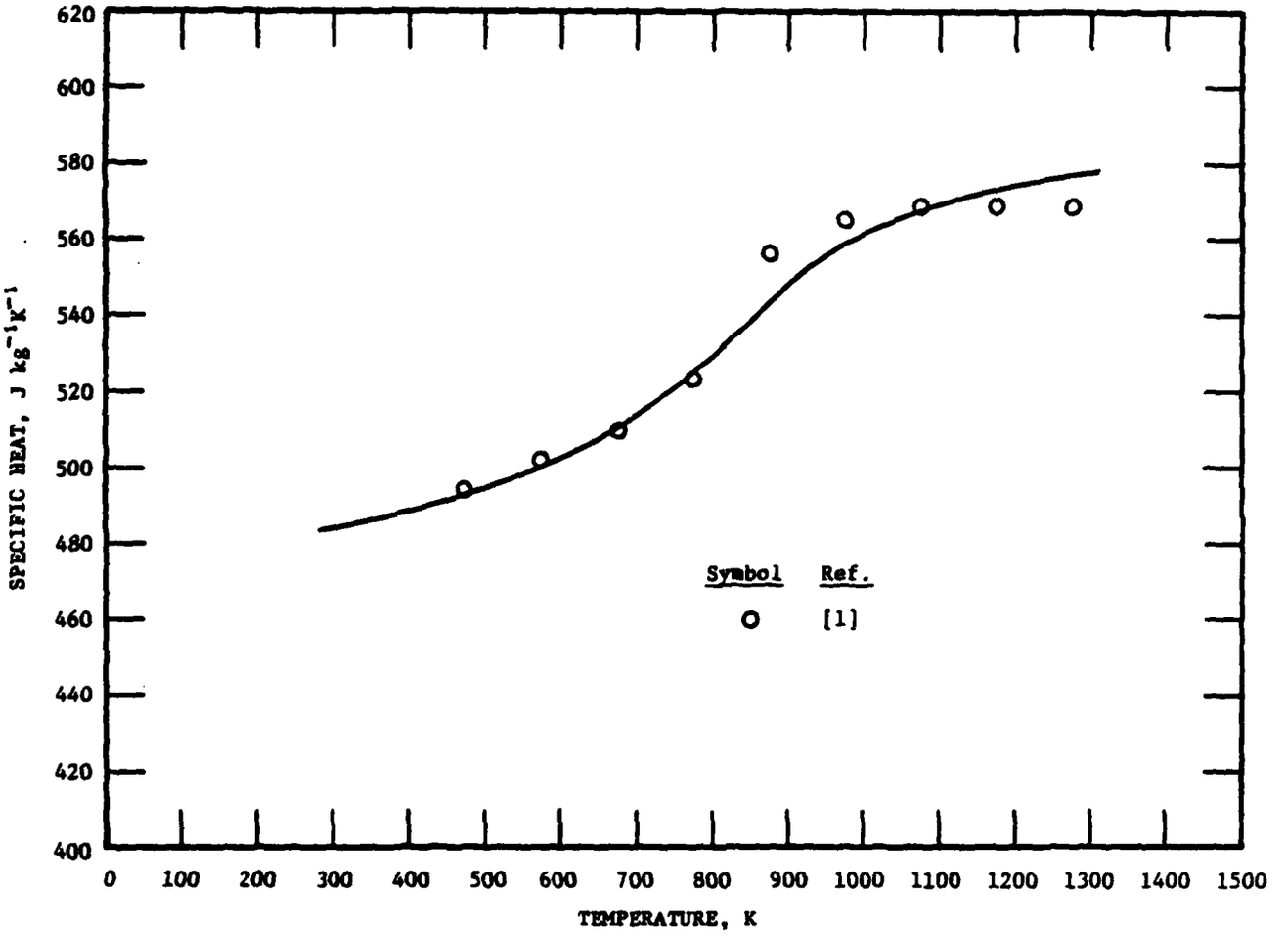

FIGURE 5.3. SPECIFIC HEAT OF X 6 CrNiWNb 16 16 STAINLESS STEEL.

5.4. X 7 CrNiAl 17 7 STAINLESS STEEL [DIN 1.4568]

The nominal composition of X 7 CrNiAl 17 7 stainless steel is 16.0–18.0% Cr, 6.5–7.75% Ni, 0.75–1.5% Al, $\leq$0.09% C, $\leq$1.0% Mn, $\leq$1.0% Si, 0.045% P, 0.03% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 631 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.4. RECOMMENDED SPECIFIC HEAT OF X 7 CrNiAl 17 7 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	450
300	454
350	473
400	489
500	517
600	537
700	554
800	569
900	580
1000	592
1100	604
1200	615
1300	627
1400	639
1500	650

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

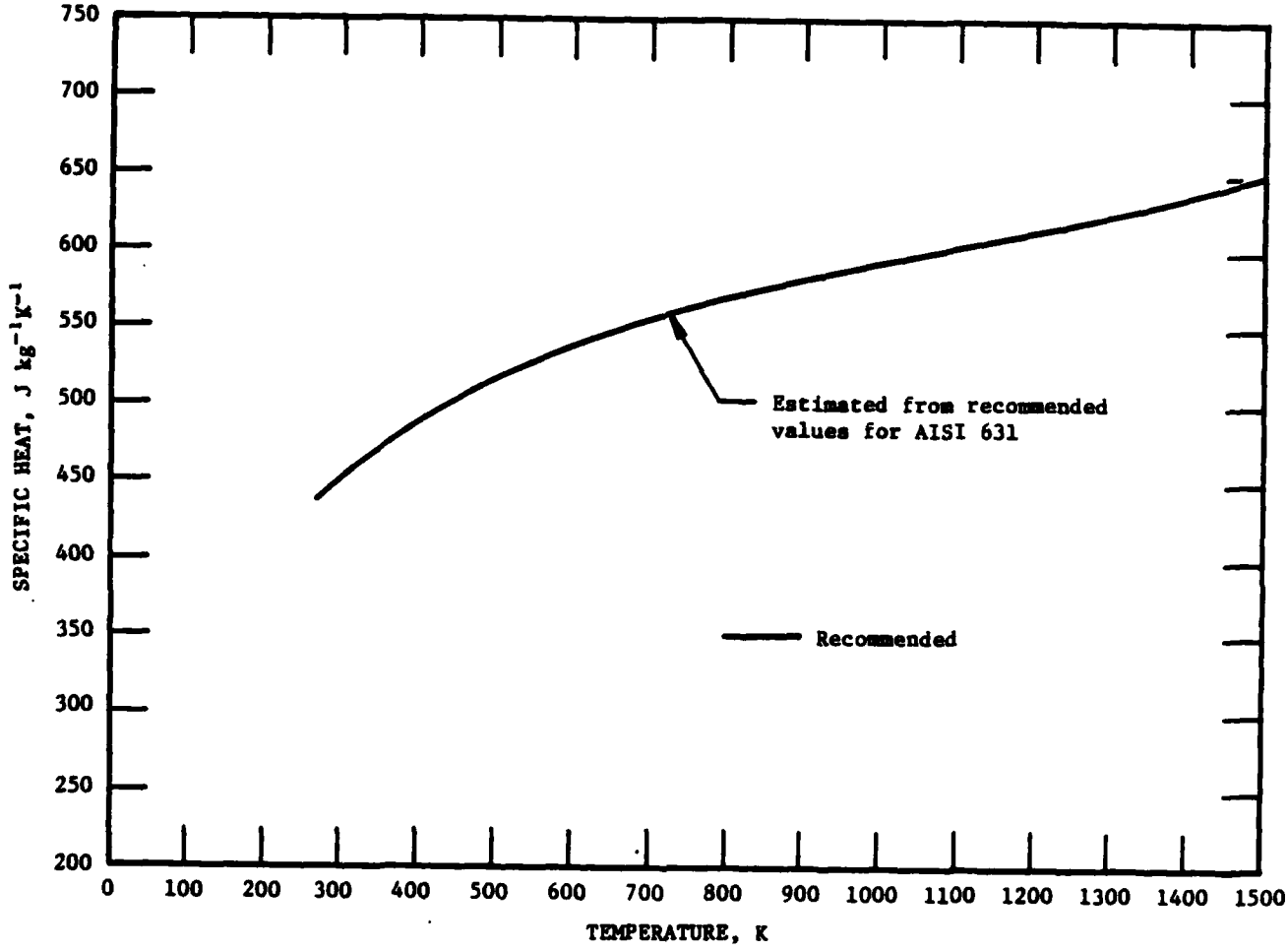

FIGURE 5.4. SPECIFIC HEAT OF X 7 CrNiAl 17 7 STAINLESS STEEL.

5.5. X 8 Cr 17 STAINLESS STEEL [DIN 1.4016]

The nominal composition of X 8 Cr 17 stainless steel is 15.5-17.5% Cr, $\leq$0.10% C, $\leq$1.0% Mn, $\leq$1.0% Si, 0.045% P, 0.03% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 430 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.5. RECOMMENDED SPECIFIC HEAT OF X 8 Cr 17 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	212	900	921
150	322	950	1088
200	384	1000	880
250	428	1050	758
273	440	1100	706
293	451	1200	665
300	455	1300	665
350	497	1400	682
400	497	1500	710
450	517		
500	538		
600	585		
700	644		
800	730		
850	802		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

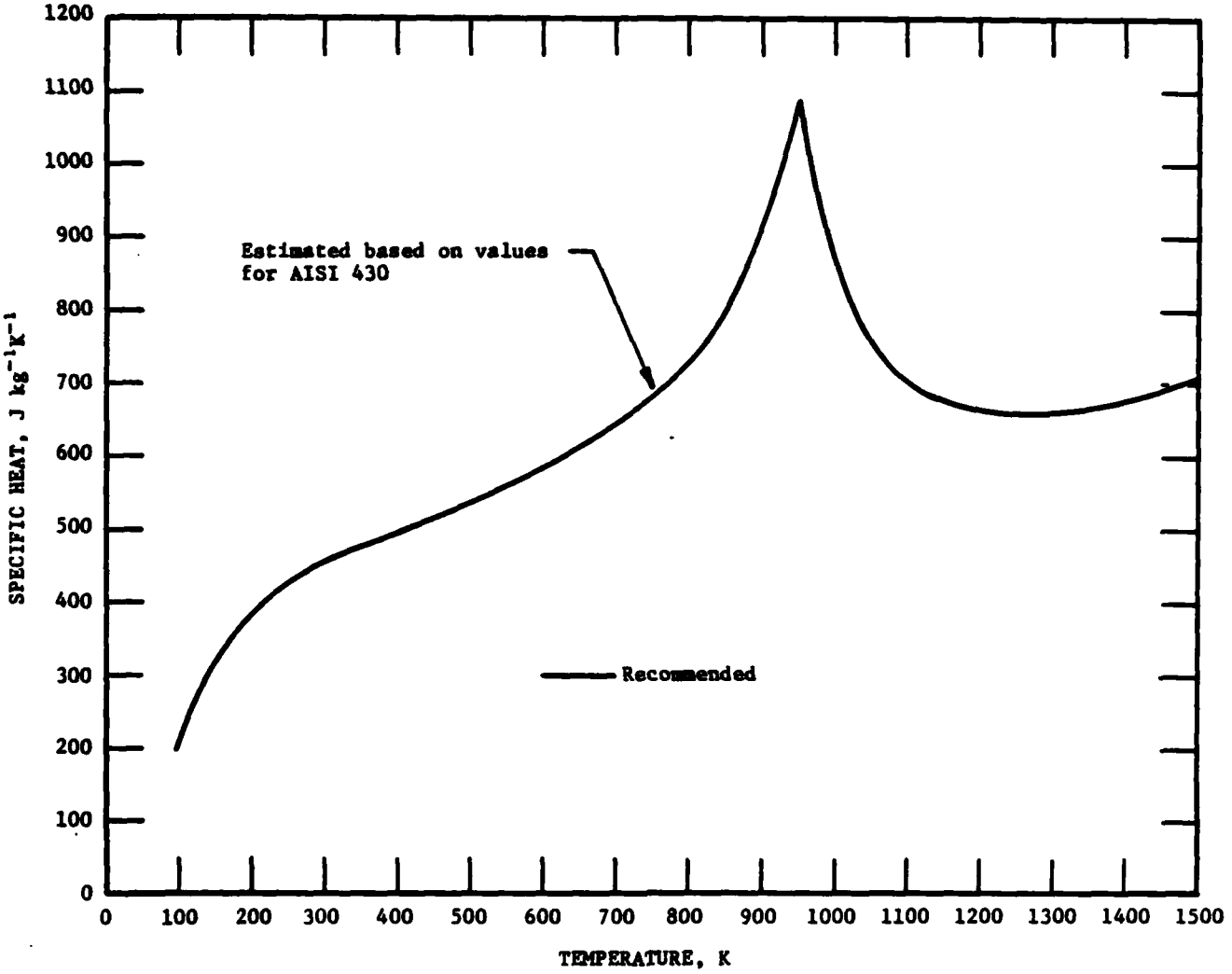

FIGURE 5.5. SPECIFIC HEAT OF X 8 Cr 17 STAINLESS STEEL.

5.6. X 8 CrNiMoBNb 16 16 STAINLESS STEEL (ATS 2) [DIN 1.4986]

The nominal composition of X 8 CrNiMoBNb 16 16 stainless steel is 15.5-17.0% Cr, 15.5-17.5% Ni, 0.05-0.10% B, 0.04-0.10% C, $\leq$1.5% Mn, 1.6-2% Mo, 0.30-0.60% Si, >10xC% (Nb+Ta), 0.045% P, 0.03% S, and balance Fe. The values for the specific heat of this steel are taken from the data of Preisendanz et al. [1]. The values from the Kopp-Neumann mixing rule are up to 7% higher below 800 K and above that, the values are slightly lower from those from Ref. [1].

TABLE 5.6. RECOMMENDED SPECIFIC HEAT OF X 8 CrNiMoBNb 16 16 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	456	1000	585
300	457	1050	588
350	460	1100	591
400	464	1150	593
450	469	1200	595
500	476	1250	596
550	484	1300	596
600	494		
650	505		
700	519		
750	536		
800	554		
850	565		
900	574		
950	580		

REFERENCE

1. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293-300, 1969.

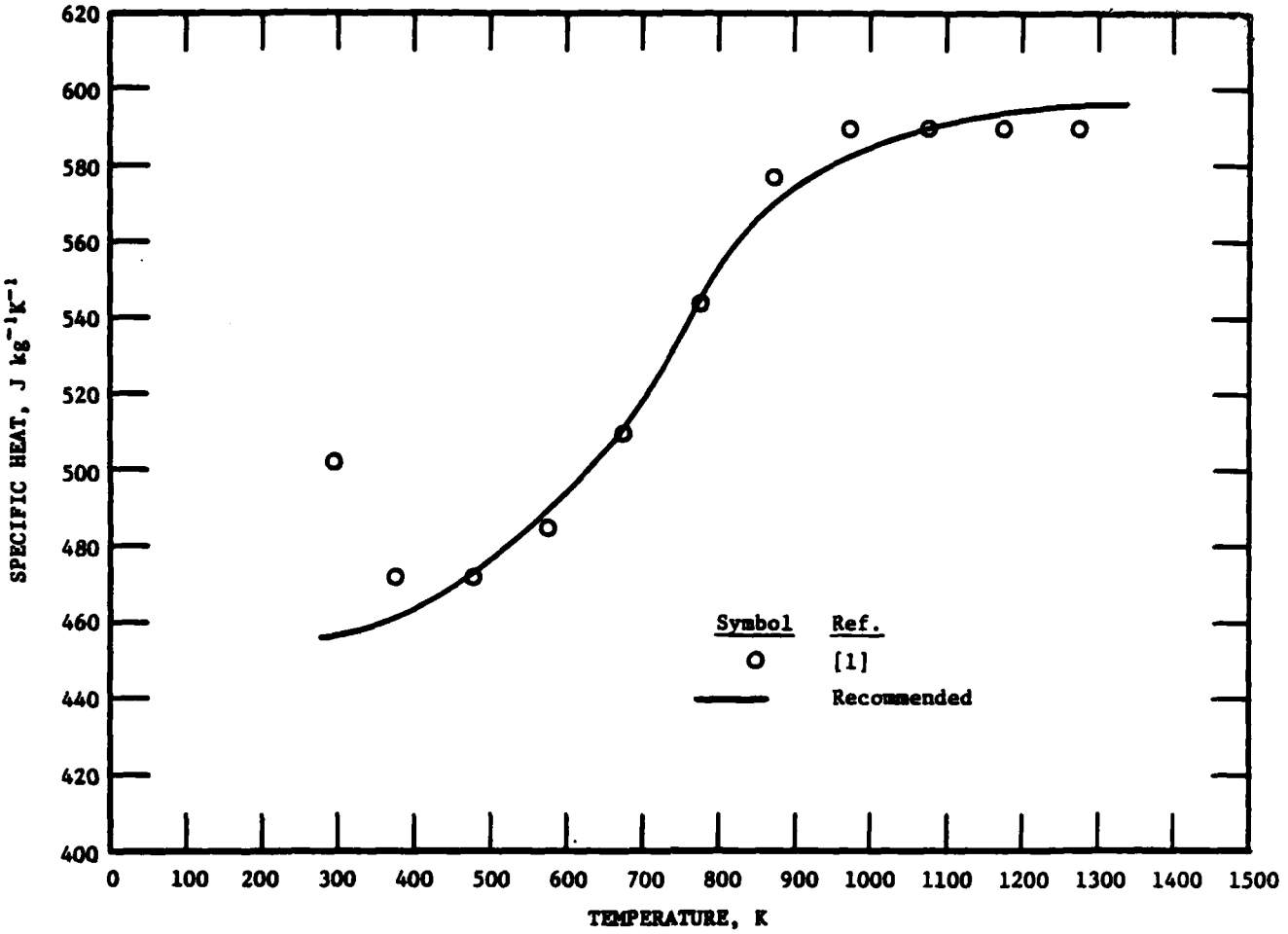

FIGURE 5.6. SPECIFIC HEAT OF X 8 CrNiMoBNb 16 16 STAINLESS STEEL.

5.7. X 8 CrNiMoNb 16 16 STAINLESS STEEL (ATS 15) [DIN 1.4981]

The nominal composition of X 8 CrNiMoNb 16 16 stainless steel is 15.5-17.5% Cr, 15.5-17.5% Ni, 0.04-0.10% C, ≤1.5% Mn, 1.6-2% Mo, 0.30-0.60% Si, 10xC% Nb, 0.045% P, 0.030% S, and balance Fe. Fink et al. [1] and Preisendanz et al. [2] have reported data for the specific heat of X 8 CrNiMoNb 16 16 stainless steel. The recommended values for the specific heat of this steel are based on the recommended values for AISI 347 stainless steel [3], whose composition is somewhat near that of this German steel. The values calculated from the Kopp-Neumann mixing rule are about 7% lower than the recommended values. The uncertainty in the recommended values is estimated to be within ±7%.

TABLE 5.7. RECOMMENDED SPECIFIC HEAT OF X 8 CrNiMoNb 16 16 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	462
300	464
350	479
400	492
450	503
500	513
600	532
700	549
800	568
900	588
1000	608
1100	629

REFERENCES

1. Fink, K., Richter, F., Lotter, U., and Schrecke, K., Thyssenforschung, 2(2), 65-80, 1970.
2. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293-300, 1969.
3. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

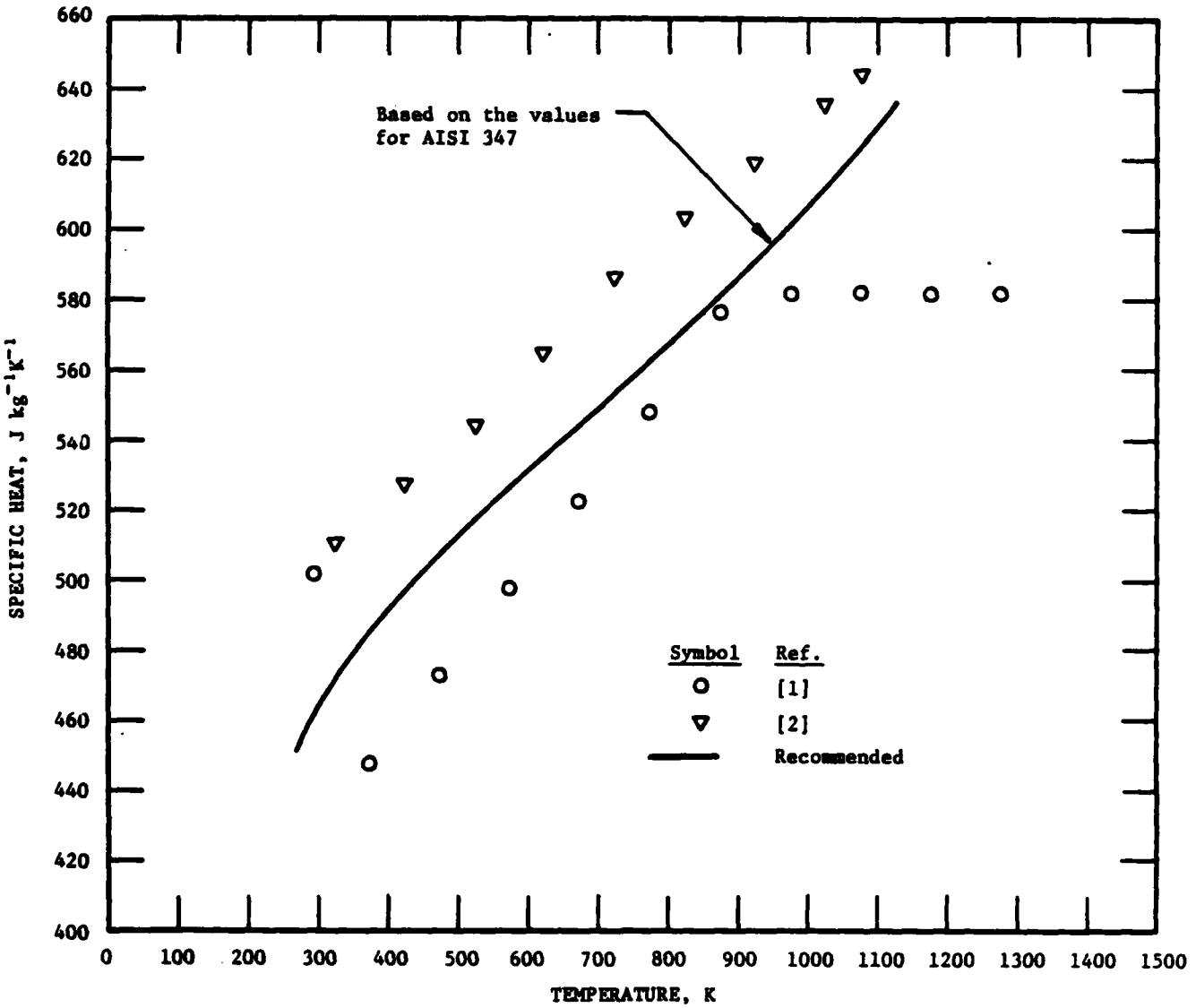

FIGURE 5.7. SPECIFIC HEAT OF X 8 CrNiMoNb 16 16 STAINLESS STEEL.

5.8. X 8 CrNiMoVNb 16 13 STAINLESS STEEL [DIN 1.4988]

The nominal composition of X 8 CrNiMoVNb 16 13 stainless steel is 15.5-17.5% Cr, 12.5-14.5% Ni, 0.04-0.10% C, 0.30-0.6% Si, $\leq$1.5% Mn, 1.1-1.5% Mo, 0.6-0.85% V, $\geq$10xC% (Nb+Ta), 0.045% P, 0.03% S, and balance Fe. The recommended values for the specific heat of this stainless steel are based on the data of Fink et al. [1]. The values calculated from the Kopp-Neumann mixing rule are about 7% lower than the recommended values. The uncertainty in the recommended values is estimated to be within $\pm$7%.

TABLE 5.8. RECOMMENDED SPECIFIC HEAT OF X 8 CrNiMoVNb 16 13 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	482
300	488
350	506
400	519
500	538
600	558
700	576
800	595
900	614
1000	631
1100	647

REFERENCE

1. Fink, K., Richter, F., Lotter, U., and Schrecke, K., Thyssenforschung, 2(2), 65-80, 1970.

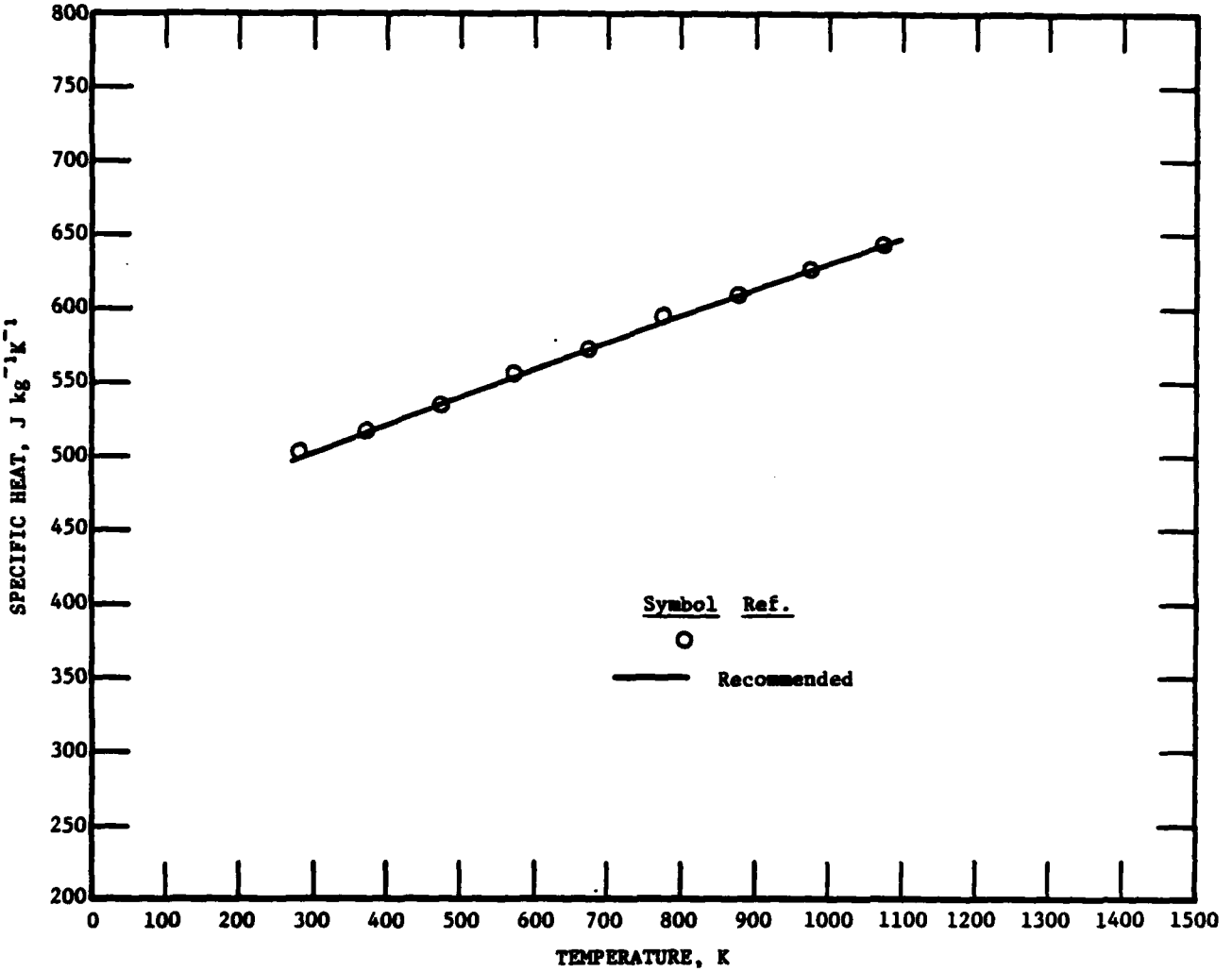

FIGURE 5.8. SPECIFIC HEAT OF X 8 CrNiMoVNb 16 13 STAINLESS STEEL.

5.9. X 8 CrNiNb 16 13 STAINLESS STEEL [DIN 1.4961]

The nominal composition of X 8 CrNiNb 16 13 stainless steel is 15.0–17.0% Cr, 12.0–14.0% Ni, 0.04–0.10% C, $\leq$1.5% Mn, $\geq$10xC% Nb, 0.30–0.60% Si, 0.045% P, 0.03% S, and balance Fe. There are two data sets available for the specific heat of this steel covering the temperature range 500–1300 K [1]. The recommended values for the specific heat are based on those recommended for AISI 347 stainless steel [3], whose composition is somewhat near that of this German steel. The data from Ref. [1] are about 10% lower than the recommended values. The data from Ref. [2] are about 6% higher than the recommended values. The uncertainty in the recommended values is estimated to be within $\pm$10%.

TABLE 5.9. RECOMMENDED SPECIFIC HEAT OF X 8 CrNiNb 16 13 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	462	1000	608
300	464	1100	629
350	479	1200	650
400	492	1300	672
450	503	1400	694
500	513	1500	718
600	532		
700	549		
800	568		
900	588		

REFERENCES

1. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293–300, 1969.

2. Fink, K., Richter, F., Lotter, U., and Schrecke, K., Thyssenforschung, 2(2), 65–80, 1970.

3. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

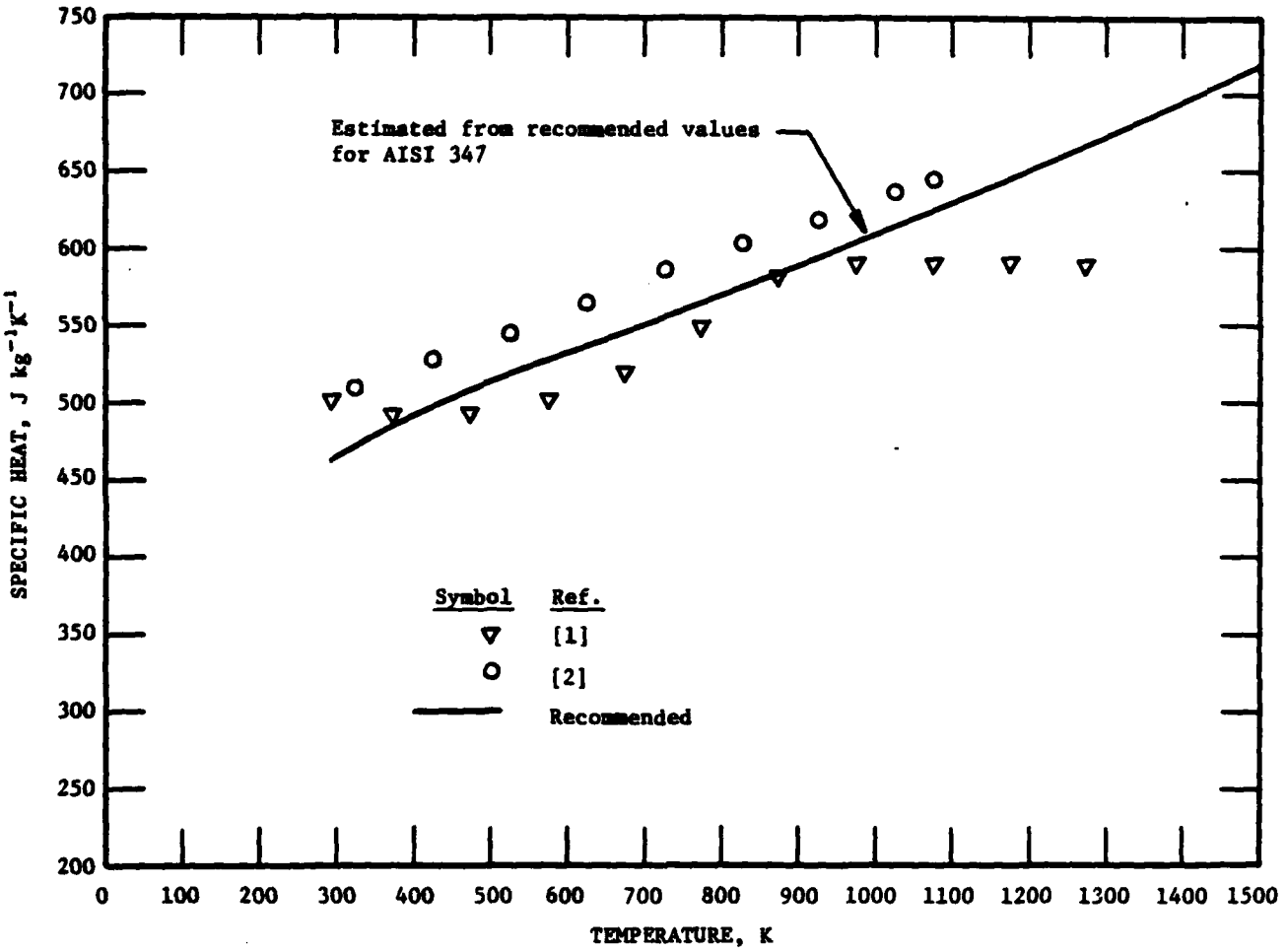

FIGURE 5.9. SPECIFIC HEAT OF X 8 CrNiNb 16 13 STAINLESS STEEL.

5.10. X 10 CrAl 13 STAINLESS STEEL [DIN 1.4724]

The nominal composition of X 10 CrAl 13 stainless steel is 12.0–14.0% Cr, 0.70–1.2% Al, ≤0.12% C, ≤1.0% Mn, 0.07–0.12% Si, 0.045% P, 0.030% S, and balance Fe. There are no experimental data available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 405 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 5.10. RECOMMENDED SPECIFIC HEAT OF X 10 CrAl 13 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	210	950	929
150	319	1000	1210
200	380	1010	957
250	417	1020	879
273	434	1030	826
293	446	1050	760
300	449	1070	745
350	472	1100	781
400	492	1120	833
450	512	1150	965
500	533	1160	671
600	577	1180	641
700	636	1200	635
800	708	1300	646
900	818	1400	665

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

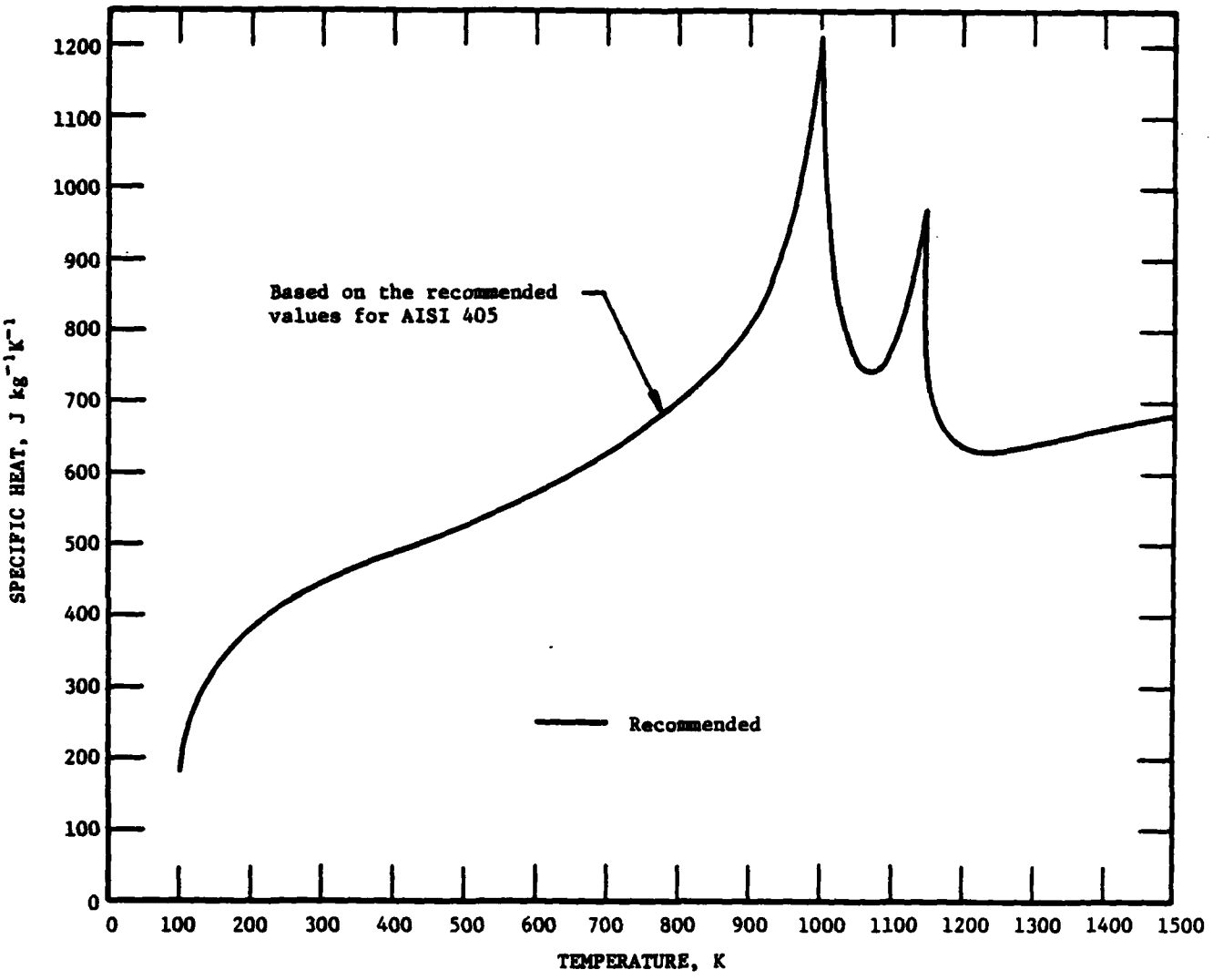

FIGURE 5.10. SPECIFIC HEAT OF X 10 CrAl 13 STAINLESS STEEL.

5.11. X 10 CrNiNb 18 9 STAINLESS STEEL [DIN 1.4550]

The nominal composition of X 10 CrNiNb 18 9 stainless steel is 17.0-19.0% Cr, 9.0-11.5% Ni, $\leq$0.12% C, $\leq$2.0% Mn, $\leq$1.0% S, $\geq$8xC% Nb, 0.045% P, 0.030% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 347 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.11. RECOMMENDED SPECIFIC HEAT OF X 10 CrNiNb 18 9 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	462	1000	608
300	464	1100	629
350	479	1200	650
400	492	1300	672
450	503	1400	694
500	513	1500	718
600	532		
700	549		
800	568		
900	588		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

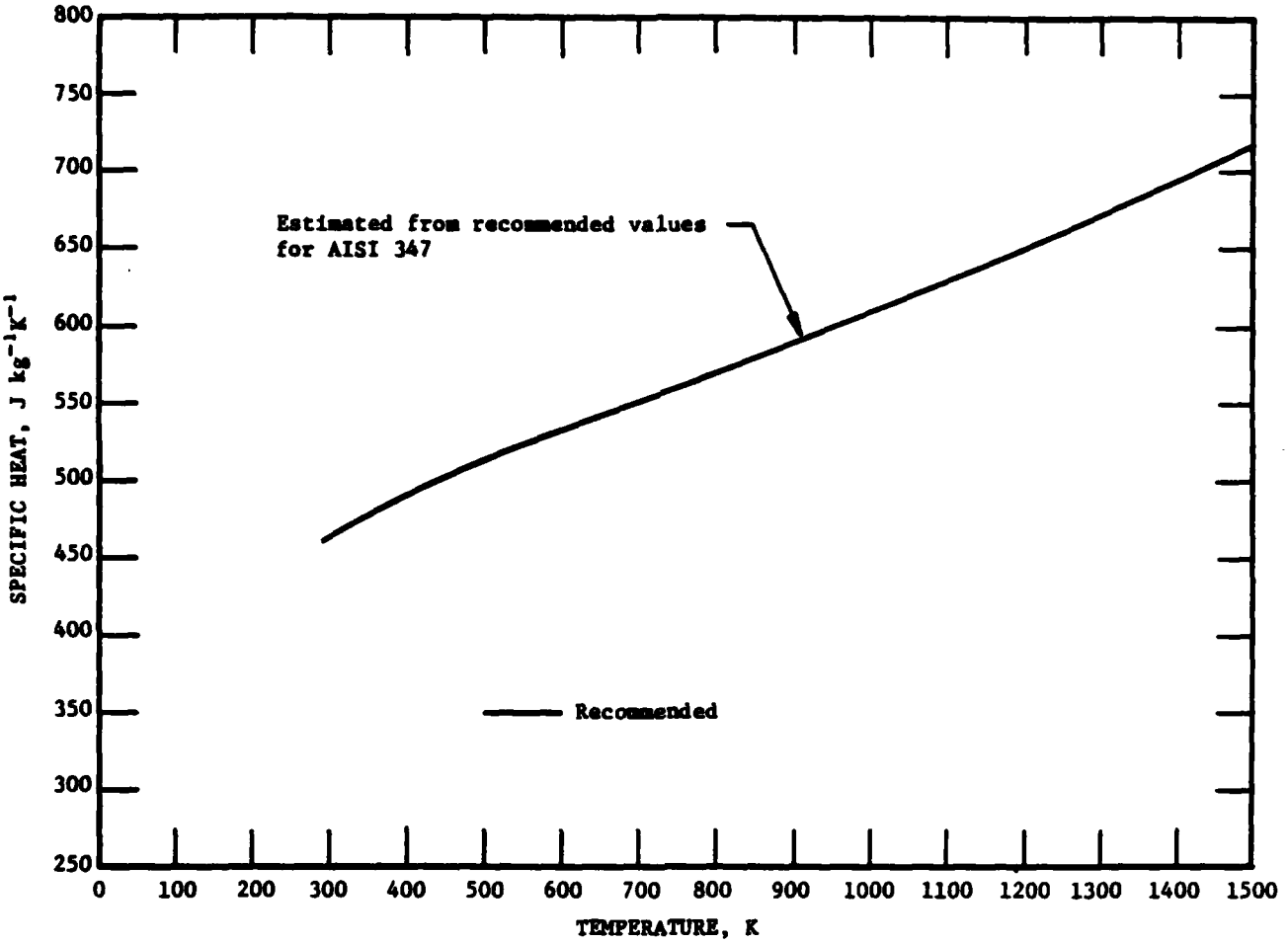

FIGURE 5.11. SPECIFIC HEAT OF X 10 CrNiNb 18 9 STAINLESS STEEL.

5.12. X 10 CrNiTi 18 9 STAINLESS STEEL [DIN 1.4541]

The nominal composition of X 10 CrNiTi 18 9 stainless steel is 17.0-19.0% Cr, 9.0-11.5% Ni, $\leq$0.10% C, $\leq$2.0% Mn, $\leq$1.0% Si, 0.045% P, 0.030% S, $\geq$5xC% Ti, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 321 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.12. RECOMMENDED SPECIFIC HEAT OF X 10 CrNiTi 18 9 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
2	1.01	293	448
3	1.51	300	452
4	2.04	350	476
7	3.70	400	495
10	5.40	450	511
15	9.87	500	525
20	11.8	600	547
25	16.2	700	563
30	24.5	800	574
40	48.0	900	586
50	79.0	1000	601
60	120	1100	617
70	160	1200	633
80	195	1300	651
90	230	1400	669
100	258		
150	344		
200	389		
250	424		
273	437		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

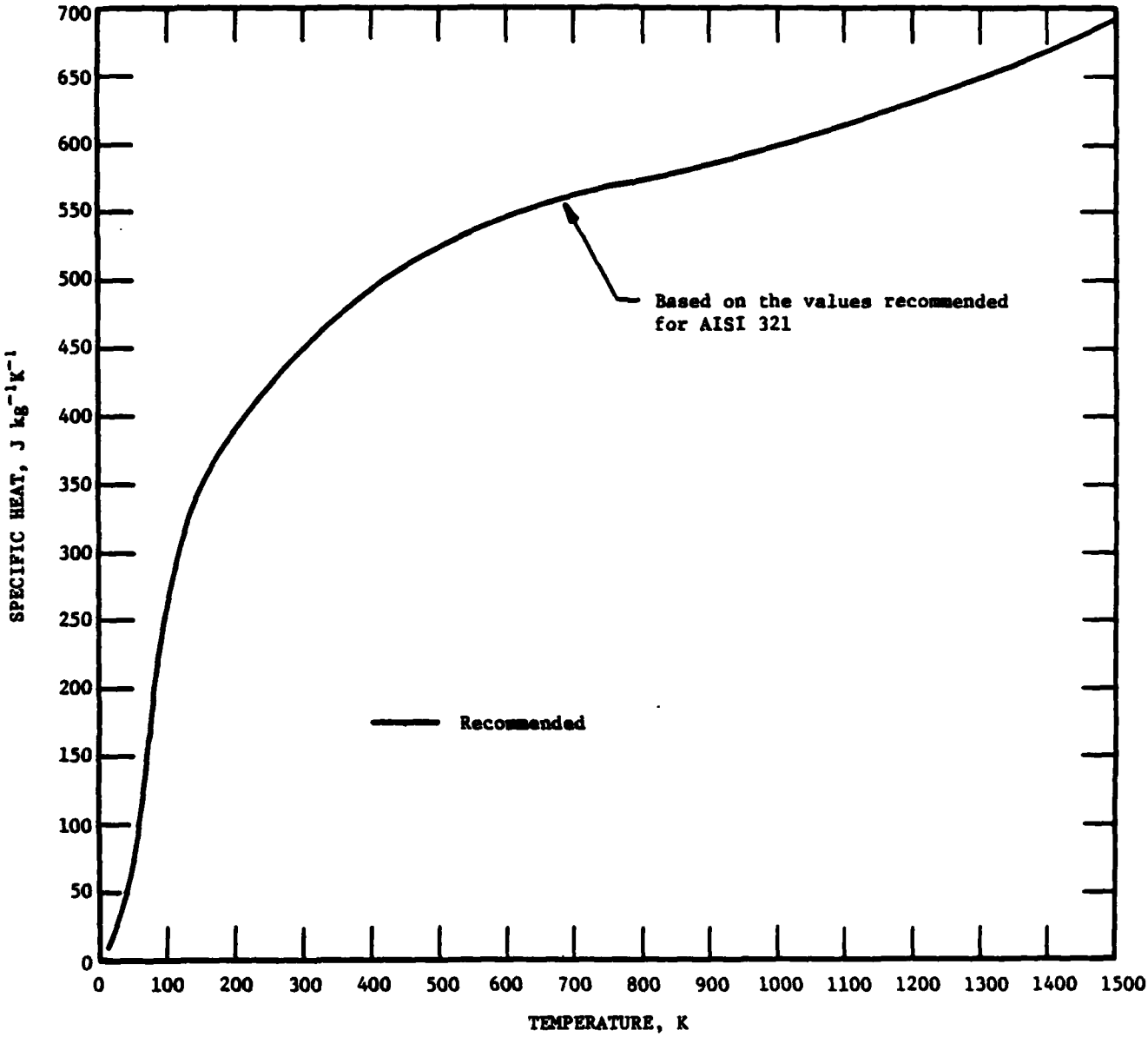

FIGURE 5.12. SPECIFIC HEAT OF X 10 CrNiTi 18 9 STAINLESS STEEL.

5.13. X 12 CrCoNi 21 20 STAINLESS STEEL (ATS 105) [DIN 1.4971]

The nominal composition of X 12 CrCoNi 21 20 stainless steel is 20.0–22.5% Cr, 19.0–21.0% Ni, 0.08–0.16% C, 18.5–21.0% Co, ≤2.0% Mn, ≤1.0% Si, 2.5–3.5% Mo, 0.10–0.20% N, 0.75–1.25% Nb, 2.0–3.0% W, 0.045% P, 0.030% S, and balance Fe. The recommended values for the specific heat of this steel are taken from the data of Preisendanz et al. [1]. The values calculated from the Kopp–Neumann mixing rule are up to 6% higher below 800 K and above that, the values are 4% lower than those from Ref. [1]. The uncertainty in the recommended values is estimated to be within ±4%.

TABLE 5.13. RECOMMENDED SPECIFIC HEAT OF X 12 CrCoNi 21 20 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	438	1000	584
300	439	1050	588
350	442	1100	591
400	445	1150	592
450	449	1200	593
500	454	1250	594
550	459	1300	594
600	466		
650	475		
700	489		
750	510		
800	539		
850	560		
900	572		
950	579		

REFERENCE

1. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293–300, 1969.

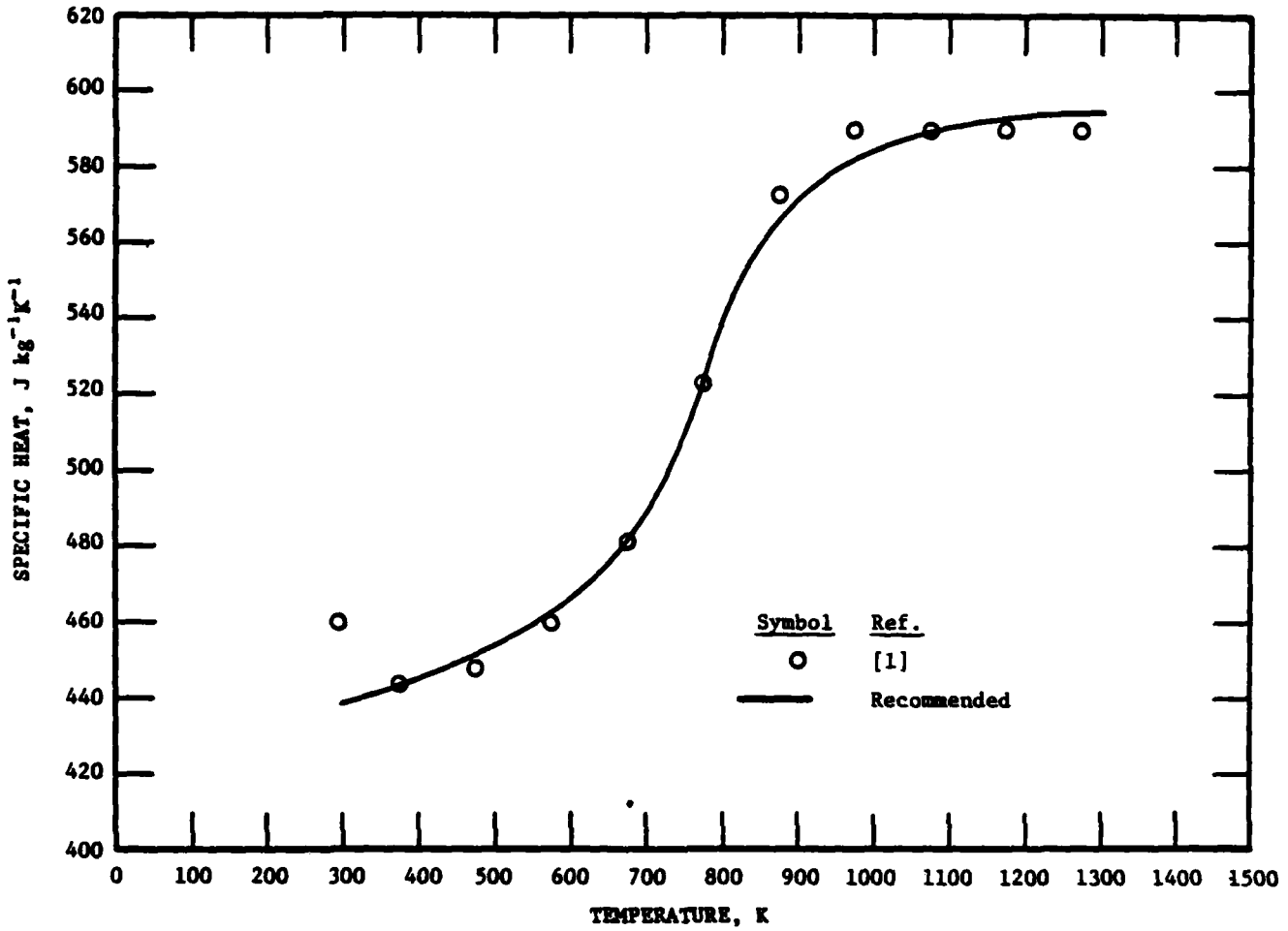

FIGURE 5.13. SPECIFIC HEAT OF X 12 CrCoNi 21 20 (ATS 105) STAINLESS STEEL.

5.14. X 12 CrMoS 17 STAINLESS STEEL [DIN 1.4104]

The nominal composition of X 12 CrMoS 17 stainless steel is 15.5–17.5% Cr, 0.10–0.17% C, $\leq$1.5% Mn, $\leq$1.0% Si, 0.20–0.30% Mo, 0.045% P, 0.15–0.35% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat of this steel are based on those recommended for AISI 430 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.14. RECOMMENDED SPECIFIC HEAT OF X 12 CrMoS 17 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	212	900	921
150	322	950	1088
200	384	1000	880
250	428	1050	758
273	440	1100	706
293	451	1200	665
300	455	1300	665
350	497	1400	682
400	497	1500	710
450	517		
500	538		
600	585		
700	644		
800	730		
850	802		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

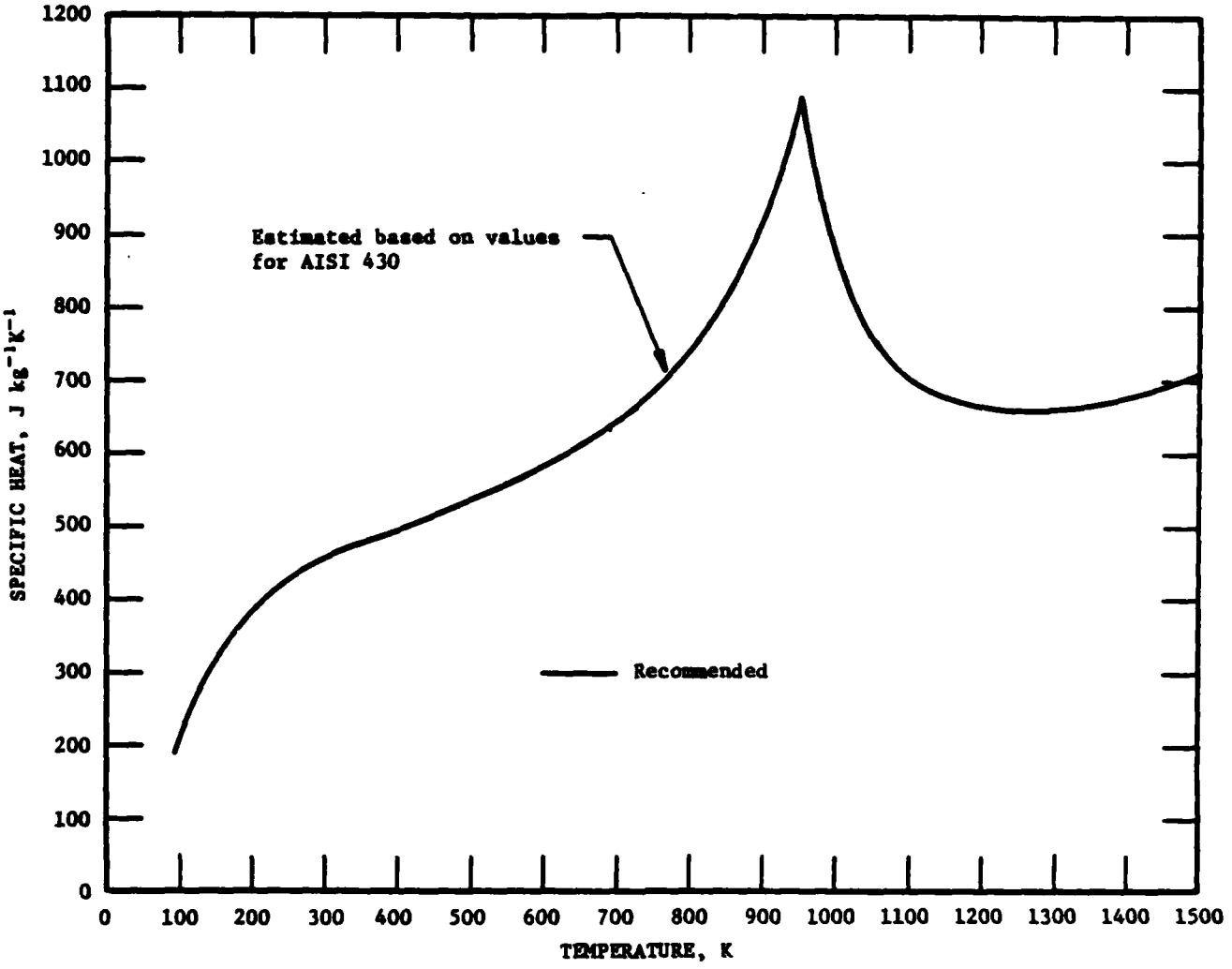

FIGURE 5.14. SPECIFIC HEAT OF X 12 CrMoS 17 STAINLESS STEEL.

5.15. X 12 CrNi 18 8 STAINLESS STEEL [DIN 1.4300]

The nominal composition of X 12 CrNi 18 8 stainless steel is 17.0–19.0% Cr, 8.0–10.0% Ni, ≤0.12% C, ≤2.0% Mn, ≤1.0% Si, 0.045% P, 0.030% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values are based on those recommended for AISI 302 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within ±7%.

TABLE 5.15. RECOMMENDED SPECIFIC HEAT OF X 12 CrNi 18 8 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	478	1000	609
300	481	1100	623
350	499	1200	637
400	515	1300	652
450	527	1400	667
500	538	1500	682
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

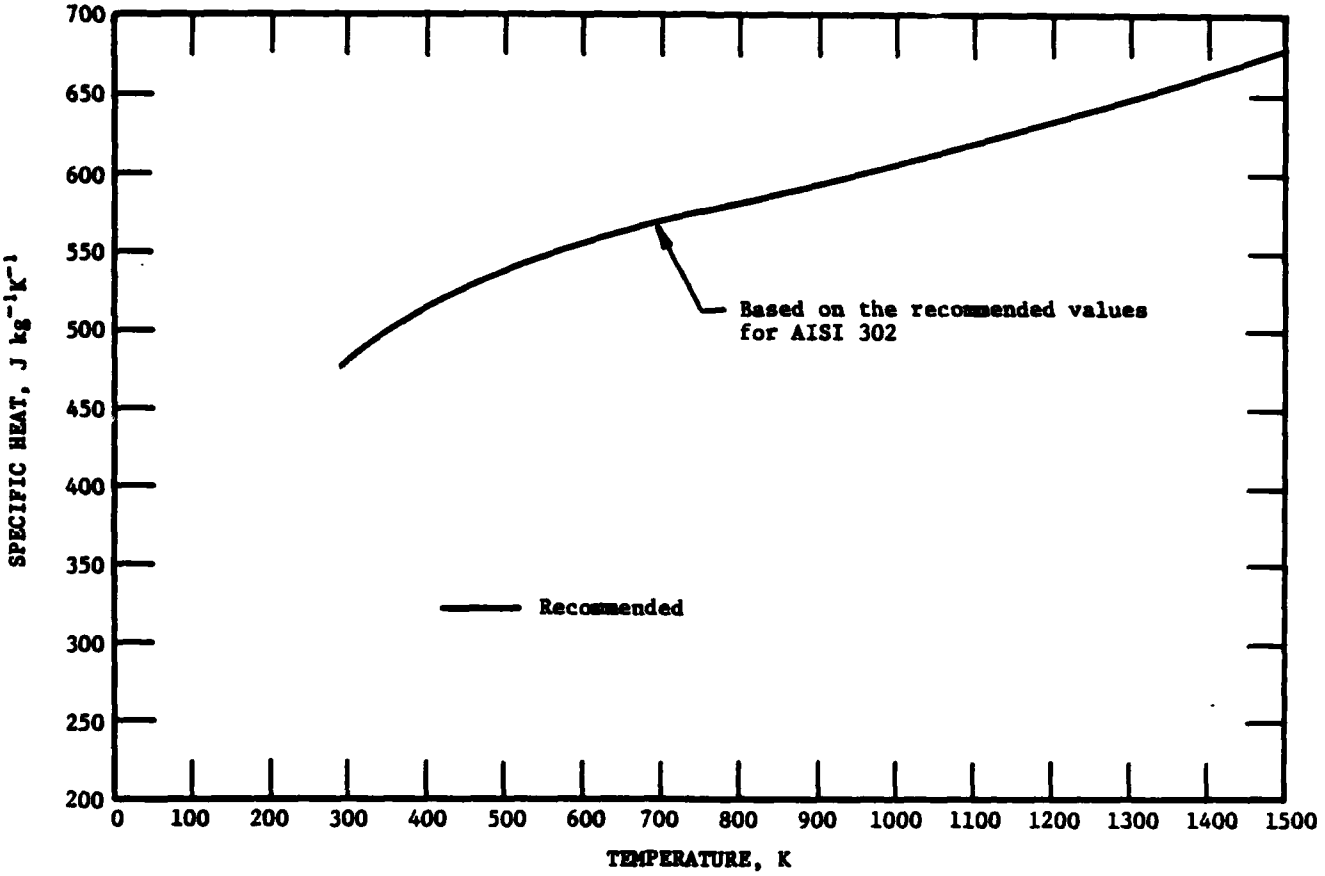

FIGURE 5.15. SPECIFIC HEAT OF X 12 CrNi 18 8 STAINLESS STEEL.

5.16. X 12 CrNiTi 18 9 STAINLESS STEEL [DIN 1.4878]

The nominal composition of X 12 CrNiTi 18 9 stainless steel is 17.0–19.0% Cr, 9.0–11.5% Ni, ≤0.12% C, ≤2.0% Mn, ≤1.0% Si, 0.045% P, 0.030% S, ≥5xC% Ti, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 321 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 5.16. RECOMMENDED SPECIFIC HEAT OF X 12 CrNiTi 18 9 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
2	1.01	293	448
3	1.51	300	452
4	2.04	350	476
7	3.70	400	495
10	5.40	450	511
15	9.87	500	525
20	11.8	600	547
25	16.2	700	563
30	24.5	800	574
40	48.0	900	586
50	79.0	1000	601
60	120	1100	617
70	160	1200	633
80	195	1300	651
90	230	1400	669
100	258		
150	344		
200	389		
250	424		
273	437		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

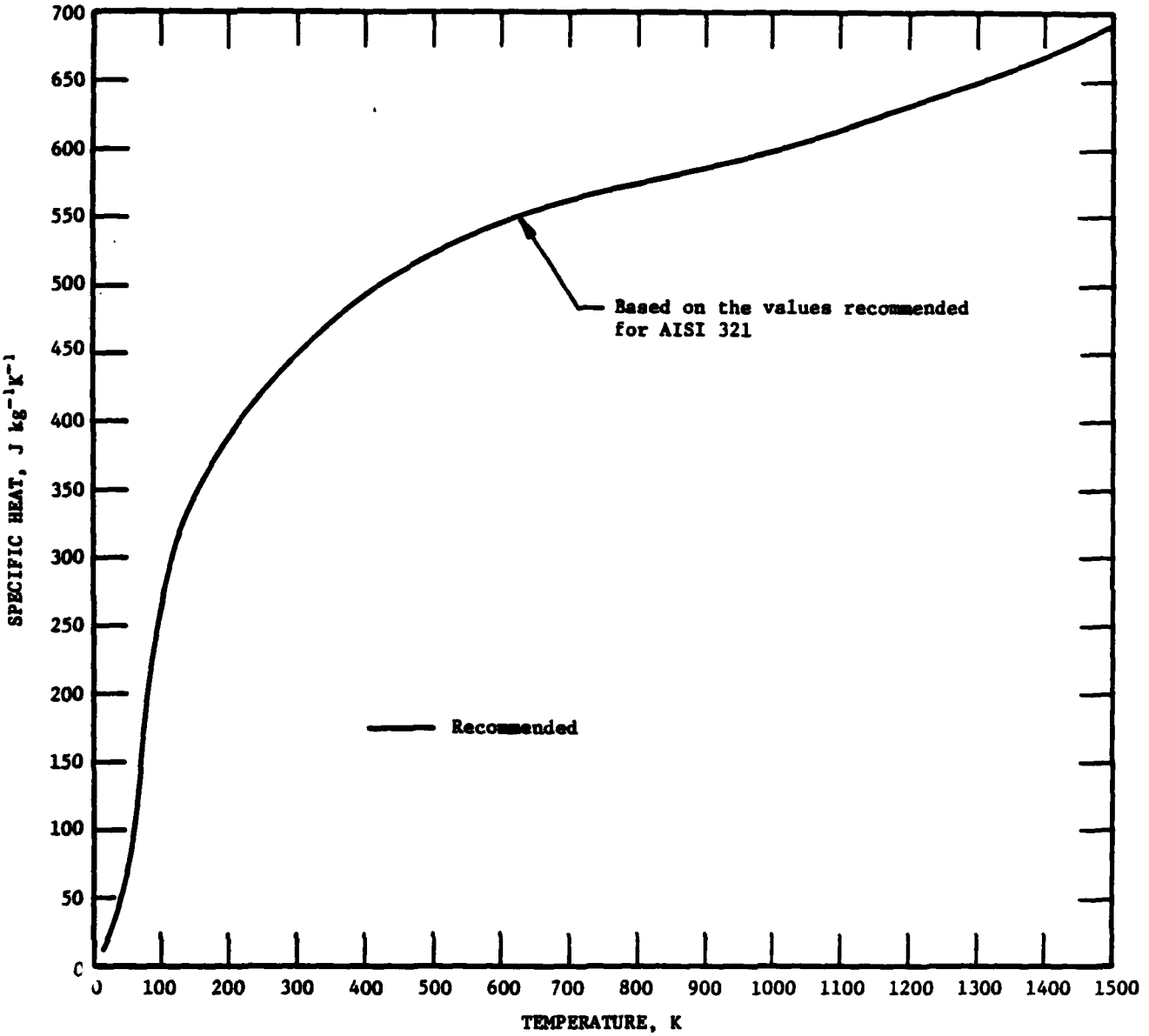

FIGURE 5.16. SPECIFIC HEAT OF X 12 CrNiTi 18 9 STAINLESS STEEL.

5.17. X 15 CrNiSi 20 12 STAINLESS STEEL [DIN 1.4828]

The nominal composition of X 15 CrNiSi 20 12 stainless steel is 19.0–21.0% Cr, 11.0–13.0% Ni, ≤0.20% C, ≤2.0% Mn, 1.5–2.5% Si, 0.035% P, 0.035% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 308 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 5.17. RECOMMENDED SPECIFIC HEAT OF X 15 CrNiSi 20 12 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
200	423	700	569
250	457	800	581
273	468	900	595
293	478	1000	609
300	481	1100	623
350	499	1200	637
400	515	1300	652
450	527	1400	667
500	538	1500	682
600	554		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

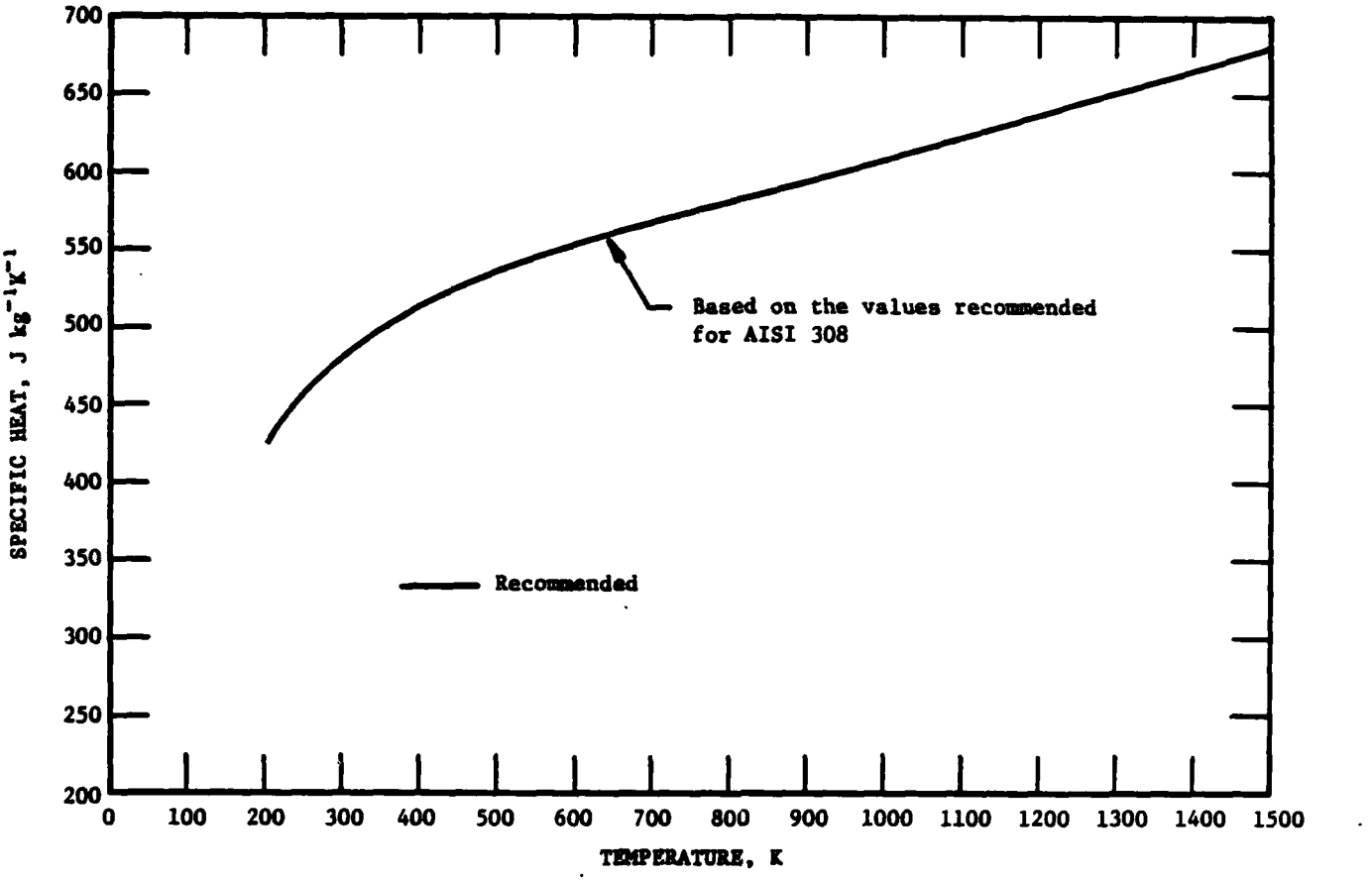

FIGURE 5.17. SPECIFIC HEAT OF X 15 CrNiSi 20 12 STAINLESS STEEL.

5.18. X 15 CrNiSi 25 20 STAINLESS STEEL [DIN 1.4841]

The nominal composition of X 15 CrNiSi 25 20 stainless steel is 24.0-26.0% Cr, 19.0-21.0% Ni, $\leq$0.2% C, $\leq$2.0% Mn, 1.5-2.5% Si, 0.045% P, 0.030% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 310 stainless steel [1], which is its composition equivalent. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 5.18. RECOMMENDED SPECIFIC HEAT OF X 15 CrNiSi 25 20 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	469
300	471
350	482
400	493
450	503
500	513
600	532
700	549
800	568
900	588
1000	608
1100	629
1200	650
1300	672
1400	694

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

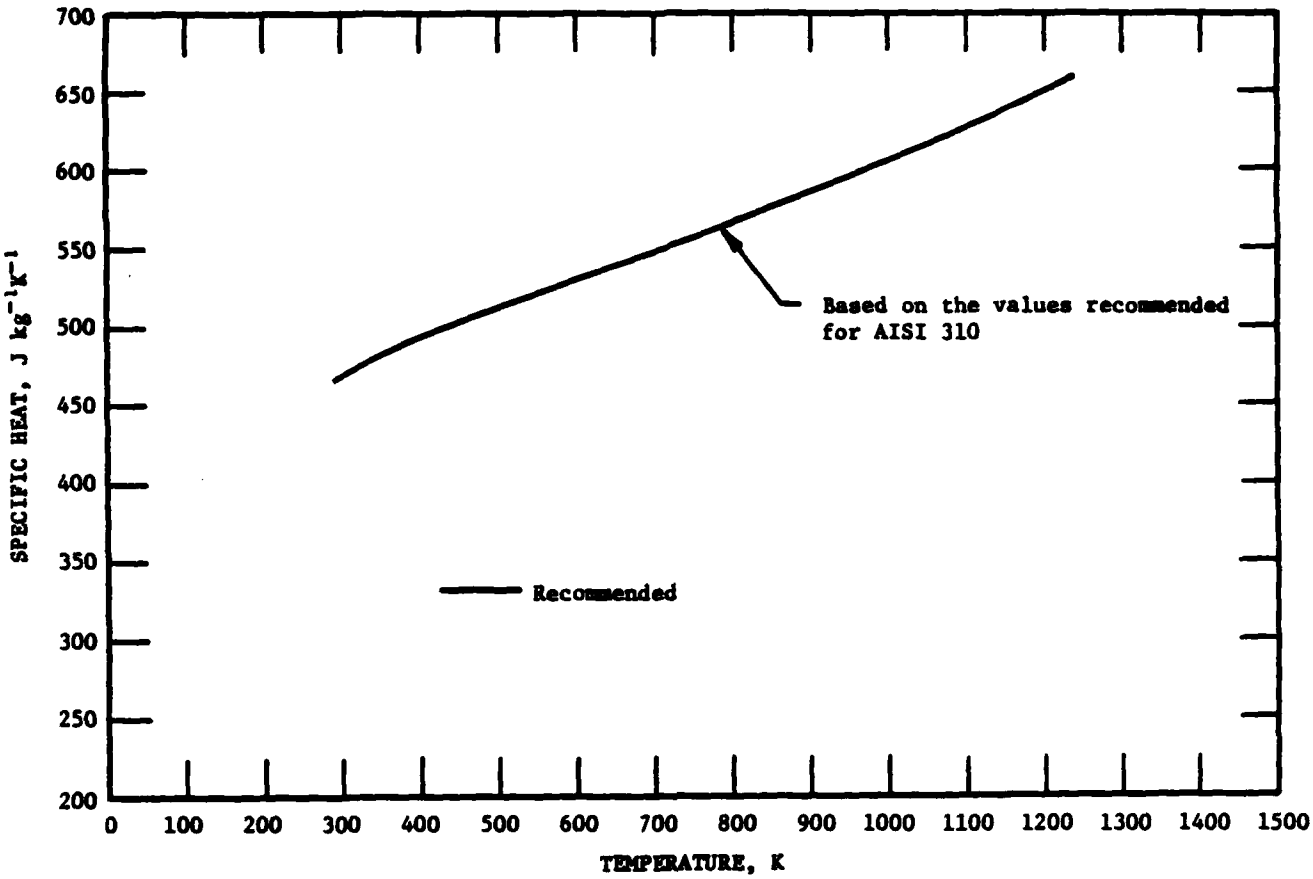

FIGURE 5.18. SPECIFIC HEAT OF X 15 CrNiSi 25 20 STAINLESS STEEL.

5.19. X 20 CrMoV 12 1 (MTS 50) [DIN 1.4922]

The composition of X 20 CrMoV 12 1 stainless steel is 11.8% Cr, 1.07% Mo, 0.80% Ni, 0.35% V, 0.19% C, 0.26% Si, 0.47% Mn, 0.014% P, 0.004% S, and balance Fe. The recommended values for the specific heat of this stainless steel are based on the data of Fink et al. [1]. The data given by Fink et al. [1] are for specimens heated in air at 1050°C for 30 minutes and then for two hours at 760°C. The values calculated from the Kopp-Neumann mixing rule agree fairly well below 500 K. The specific heat values recommended for AISI 420 stainless steel are in good agreement with the values listed below for X 20 CrMoV 12 1 stainless steel. The uncertainty in these values is about ±3%.

TABLE 5.19. RECOMMENDED SPECIFIC HEAT OF X 20 CrMoV 12 1 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	446
300	449
350	472
400	492
450	512
500	533
600	577
700	636
800	708
900	818

REFERENCE

1. Fink, K., Richter, F., Lotter, U., and Schrecke, K., Thyssenforschung, 2(2), 65-80, 1970.

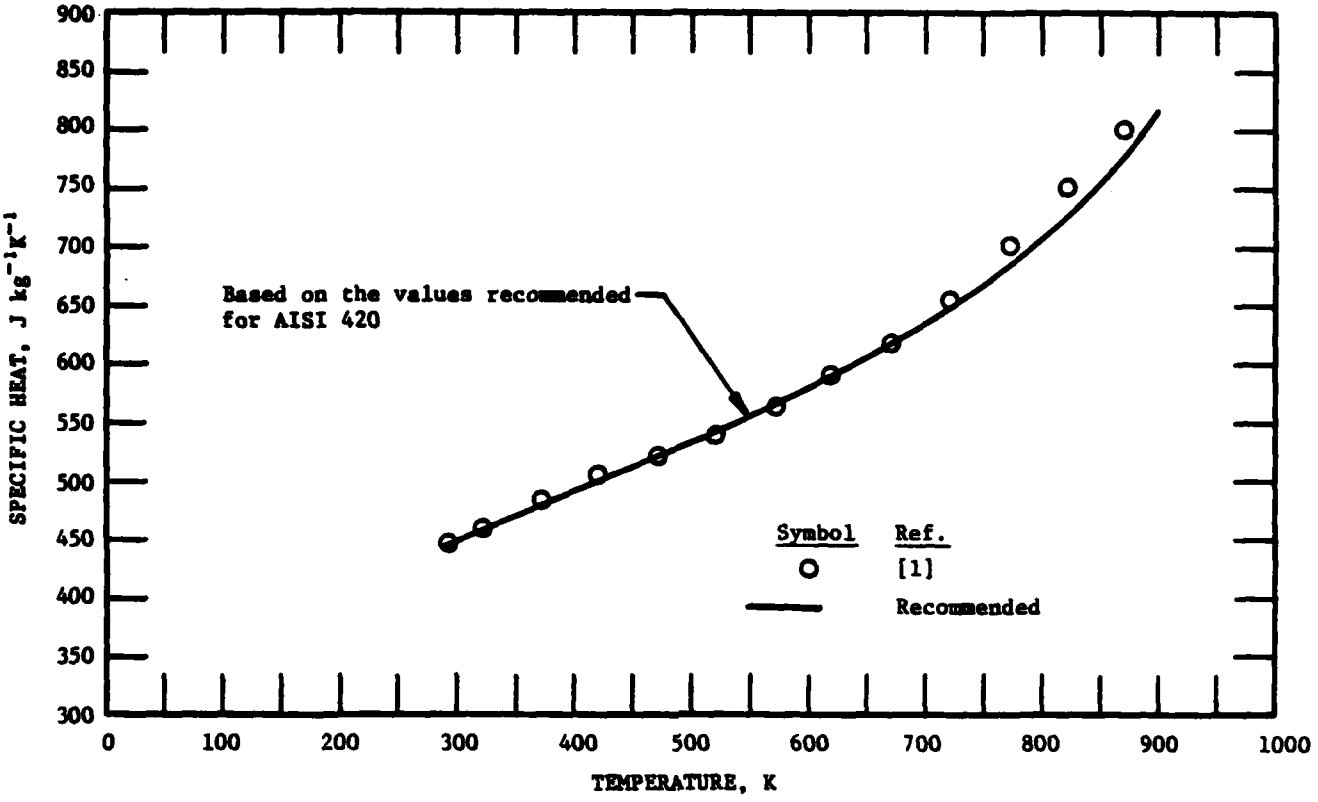

FIGURE 5.19. SPECIFIC HEAT OF X 20 CrMoV 12 1 STAINLESS STEEL.

5.20. X 40 CrNiCoNb 17 13 STAINLESS STEEL (ATS 101)

The average composition of X 40 CrNiCoNb 17 13 stainless steel is 16.80% Cr, 0.42% C, 0.98% Si, 0.97% Mn, 0.013% P, 0.006% S, 10.33% Co, 0.07% Cu, 2.14% Mo, 0.021% N, 3.12% (Nb+Ta), 13.19% Ni, 2.56% W, and balance Fe. The recommended values for the specific heat of this steel are taken from the data of Preisendanz et al. [1]. The values from the Kopp-Neumann mixing rule, in general, are up to 9% higher than those recommended for this stainless steel. The uncertainty in the recommended values is estimated to be about ±10%.

TABLE 5.20. RECOMMENDED SPECIFIC HEAT OF X 40 CrNiCoNb 17 13 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
293	443	1000	580
300	444	1050	583
350	447	1100	586
400	453	1150	588
450	460	1200	590
500	468	1250	591
550	479	1300	592
600	492		
650	508		
700	528		
750	544		
800	555		
850	563		
900	570		
950	575		

REFERENCE

1. Preisendanz, H., Spyra, W., and Schueler, P., DEW-Tech. Ber., 9(2), 293-300, 1969.

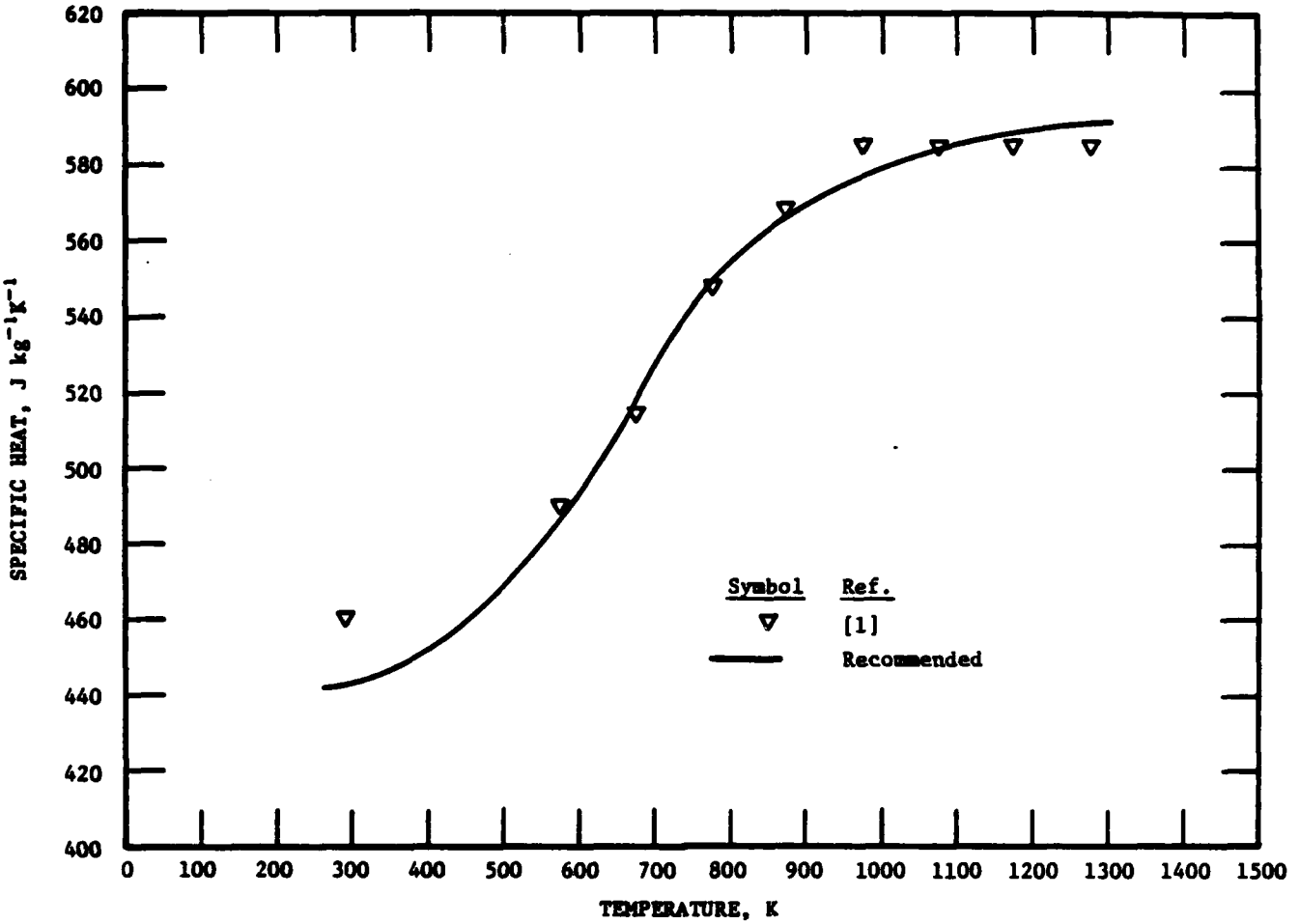

FIGURE 5.20. SPECIFIC HEAT OF X 40 CrNiCoNb 17 13 STAINLESS STEEL.

6. JAPANESE STAINLESS STEELS

6.1. DSE STAINLESS STEEL

The nominal composition of DSE stainless steel is 11.95% Cr, 6.95% W, 4.85% Co, 0.25% C, 0.45% Si, 0.43% Mn, 0.008% P, 0.019% S, 0.48% V, and balance Fe. The recommended values for the specific heat of this steel are based on the data of Nishimura [1]. The values below 800 K calculated from the Kopp-Neumann mixing rule are about 8% lower than the recommended values. The uncertainty in the recommended values is estimated to be within $\pm$8% below 800 K and slightly higher above that.

TABLE 6.1. RECOMMENDED SPECIFIC HEAT OF DSE STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
575	544
600	546
650	552
700	562
750	582
800	610
850	660
900	736
950	865
975	948

REFERENCE

1. Nishimura, T., Tetsu To Hagane, 50(10), 1449-57, 1964.

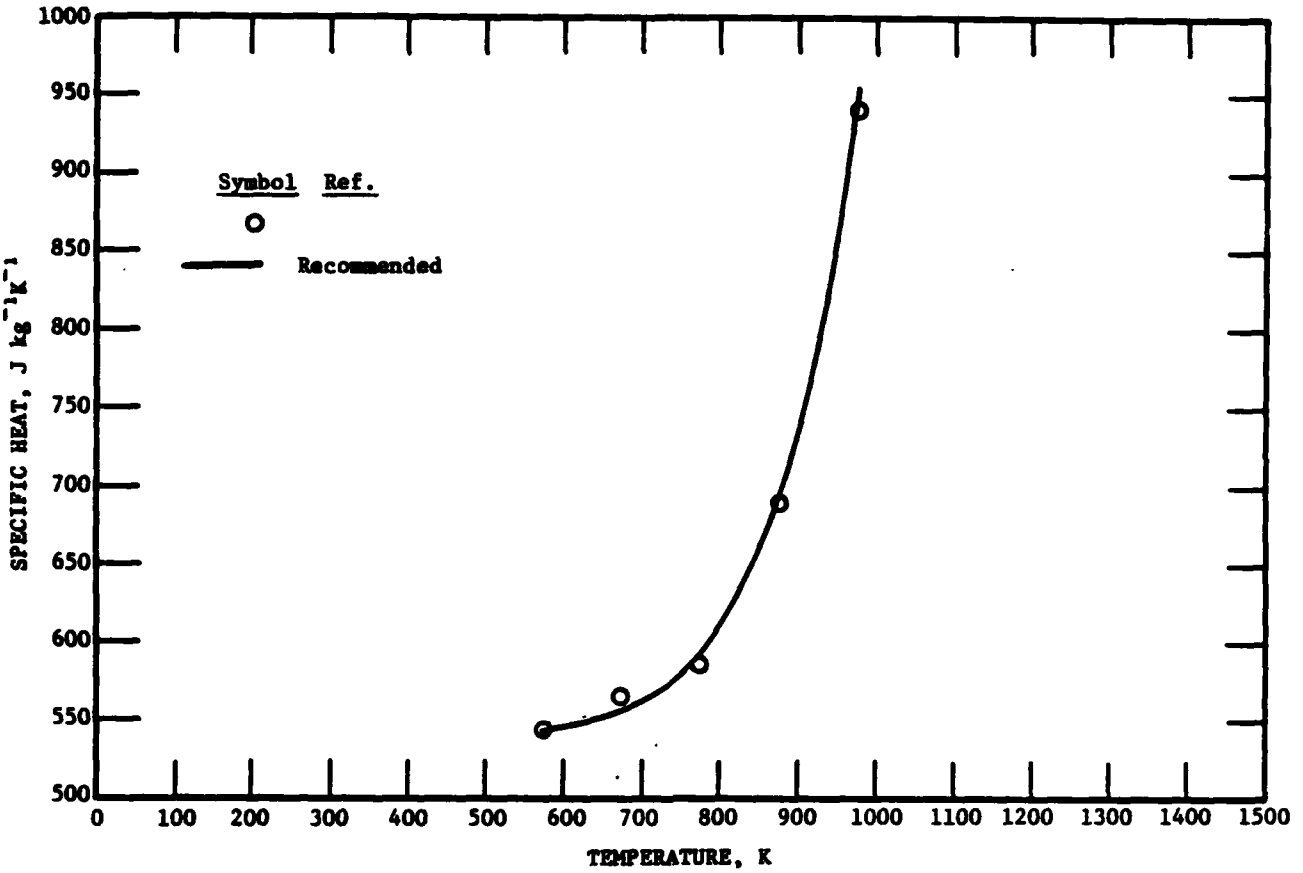

FIGURE 6.1. SPECIFIC HEAT OF DSE STAINLESS STEEL.

6.2. DSF STAINLESS STEEL

The composition of DSF stainless steel is 11.98% Cr, 9.20% Co, 7.75% W, 0.26% C, 0.43% Si, 0.43% Mn, 0.008% P, 0.018% S, 0.43% V, and balance Fe. The recommended values for the specific heat of this steel in annealed condition are based on the data of Nishimura [1]. The values below 800 K calculated from the Kopp-Neumann mixing rule are about 9% lower than the recommended values. The uncertainty in the recommended values is estimated to be within 10% below 800 K and slightly higher above that.

TABLE 6.2. RECOMMENDED SPECIFIC HEAT OF DSF STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
575	502
600	508
650	519
700	532
750	552
800	581
850	622
900	682
950	765
975	820

REFERENCE

1. Nishimura, T., Tetsu To Hagane, 50(10), 1449-57, 1964.

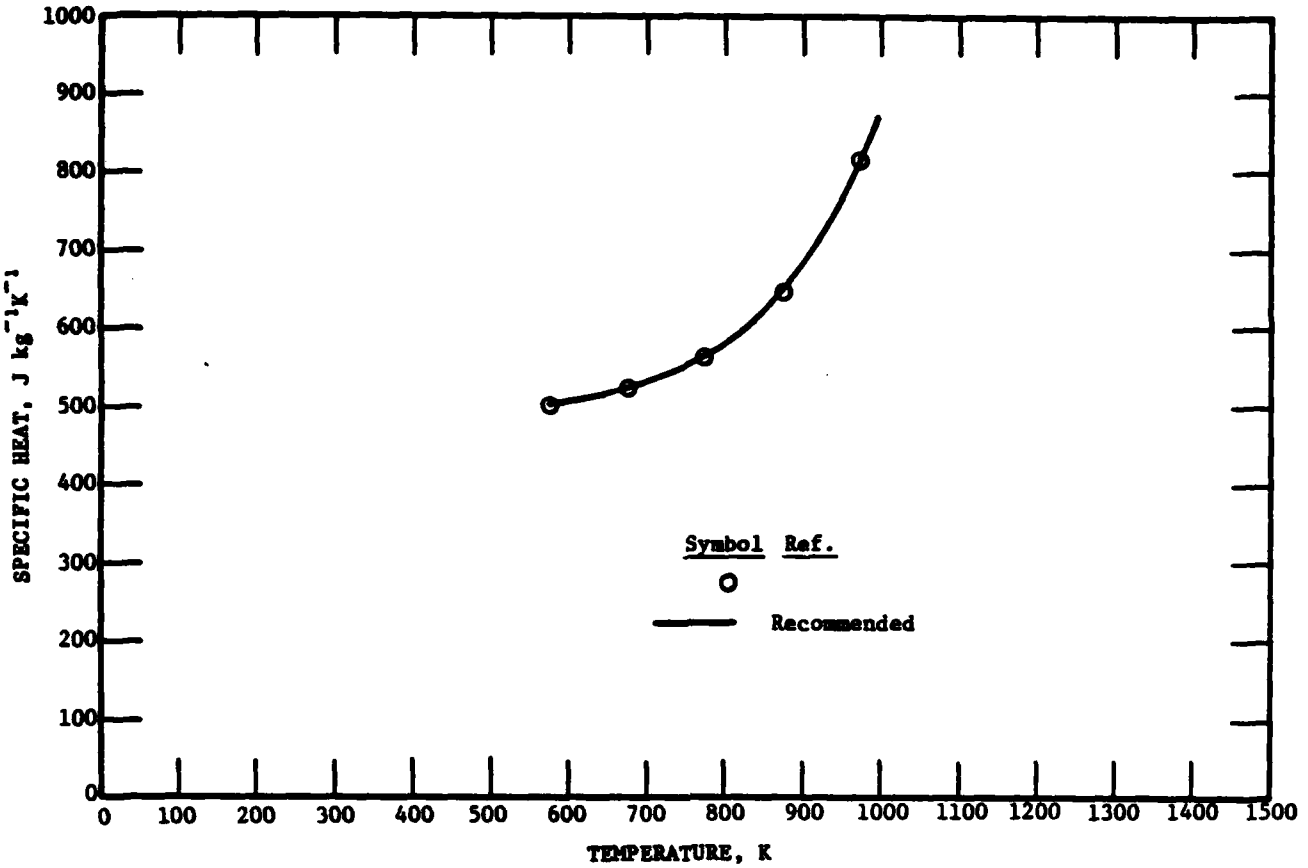

FIGURE 6.2. SPECIFIC HEAT OF DSF STAINLESS STEEL.

6.3. SUS 304 STAINLESS STEEL

The nominal composition of SUS 304 stainless steel is 18.0-20.0% Cr, 8.0-11.0% Ni, 0.08% C, 2.0% Mn, 1.0% Si, 0.04% P, 0.03% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for its equivalent, AISI 304 stainless steel [1]. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 6.3. RECOMMENDED SPECIFIC HEAT OF SUS 304 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481	1600	704
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

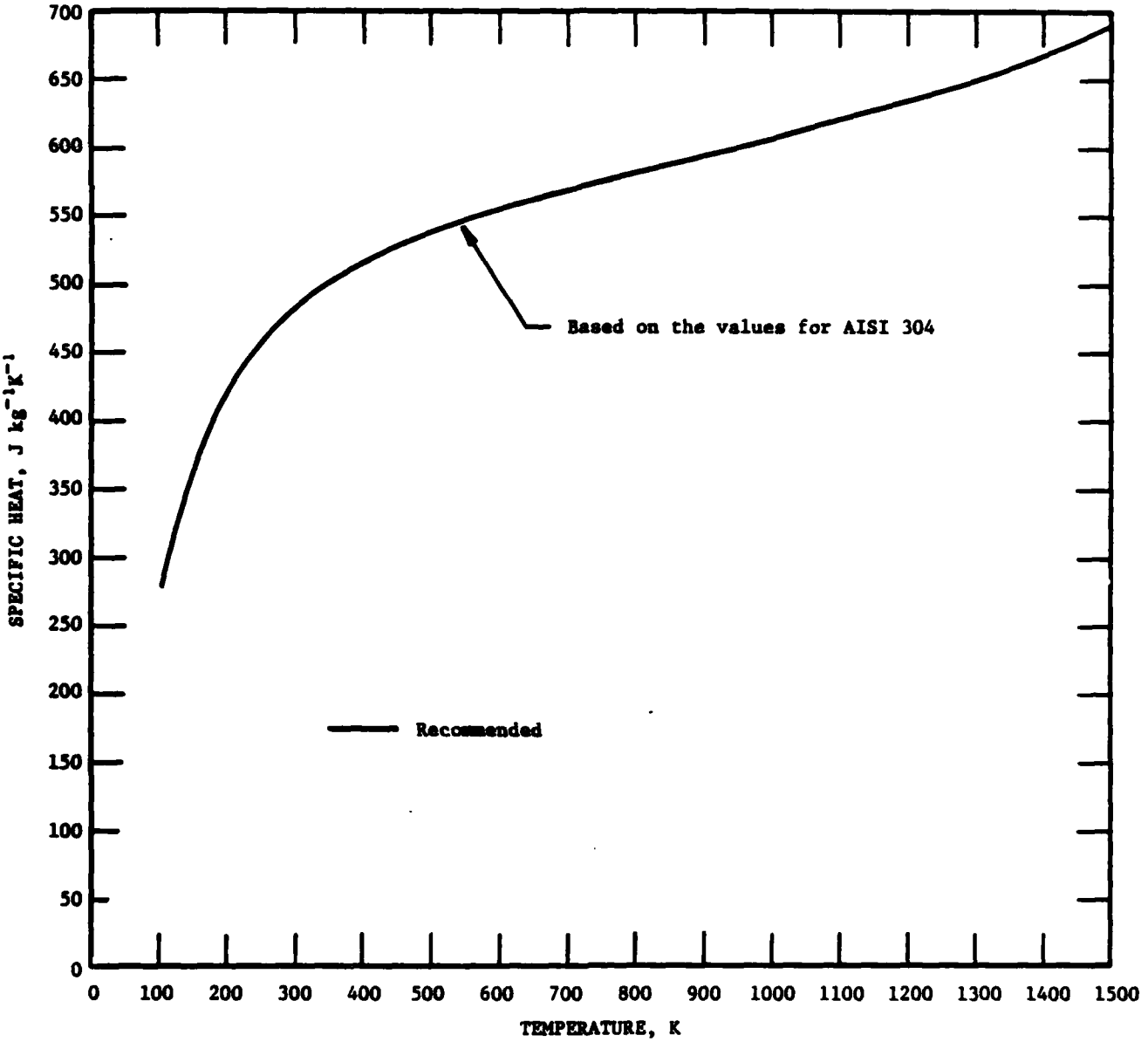

FIGURE 6.3. SPECIFIC HEAT OF SUS 304 STAINLESS STEEL.

7. POLISH STAINLESS STEELS

7.1. LH17N8 STAINLESS STEEL

The composition of LH17N8 stainless steel is 16.7% Cr, 7.60% Ni, 0.45% Si, 0.31% Mn, 0.11% C, 0.024% S, 0.020% P, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values are based on those recommended for AISI 301 [1]. The composition of LH17N8 stainless steel is somewhat similar to that of AISI 301. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 7.1. RECOMMENDED SPECIFIC HEAT OF LH17N8 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
25	20.8	300	481
30	30.9	350	499
35	42.8	400	515
40	55.9	450	527
50	91.0	500	538
60	132	600	554
70	172	700	569
80	208	800	581
90	240	900	595
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

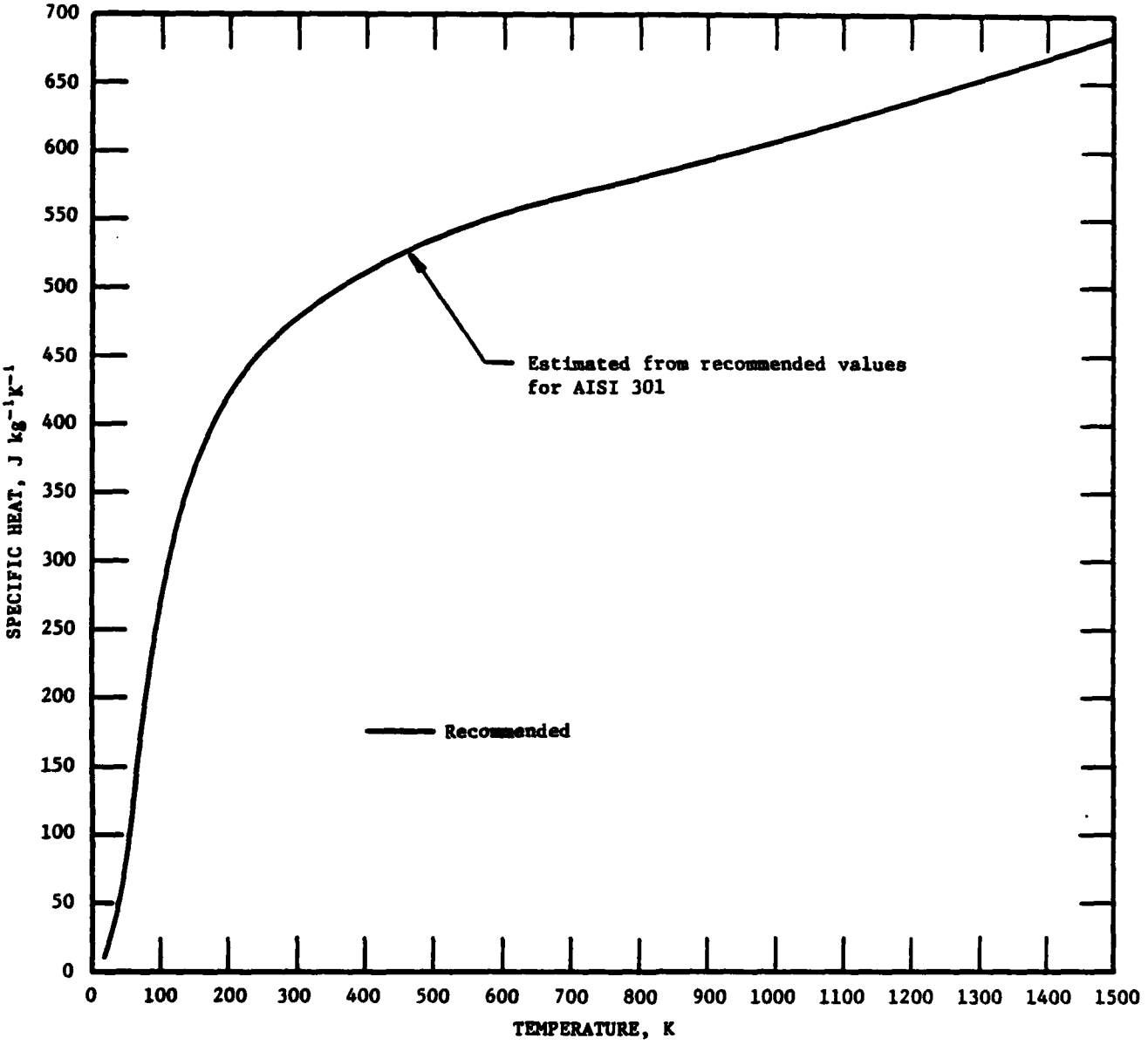

FIGURE 7.1. SPECIFIC HEAT OF LH17N8 STAINLESS STEEL.

7.2. 1H18N9 STAINLESS STEEL

The composition of 1H18N9 stainless steel is 18.96% Cr, 8.36% Ni, 0.12% C, 1.12% Mn, 0.83% Si, 0.030% P, 0.023% S, and balance Fe. There is only one data set available for the specific heat of this steel covering the temperature range 2-14 K [1]. The recommended values are based on Ref. [1] and also on the values recommended for its equivalent, AISI 304 stainless steel [2]. The electronic specific heat coefficient is 0.467 J $kg^{-1}K^{-2}$. The uncertainty in the recommended values is estimated to be within $\pm$5%.

TABLE 7.2. RECOMMENDED SPECIFIC HEAT OF 1H18N9 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
1	0.467	293	478
4	1.89	300	481
7	3.38	400	515
10	5.04	500	538
15	8.13	600	554
20	13.1	700	569
25	20.8	800	581
30	30.9	900	595
35	42.8	1000	609
40	55.9	1100	623
50	91.0	1200	637
60	132	1300	652
70	172	1400	668
80	208		
90	240		
100	268		
150	370		
200	423		
250	457		
273	468		

REFERENCES

1. Mazur, J. and Zacharko, T.W., Acta Phys. Pol., 33(4), 657-63, 1968.

2. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

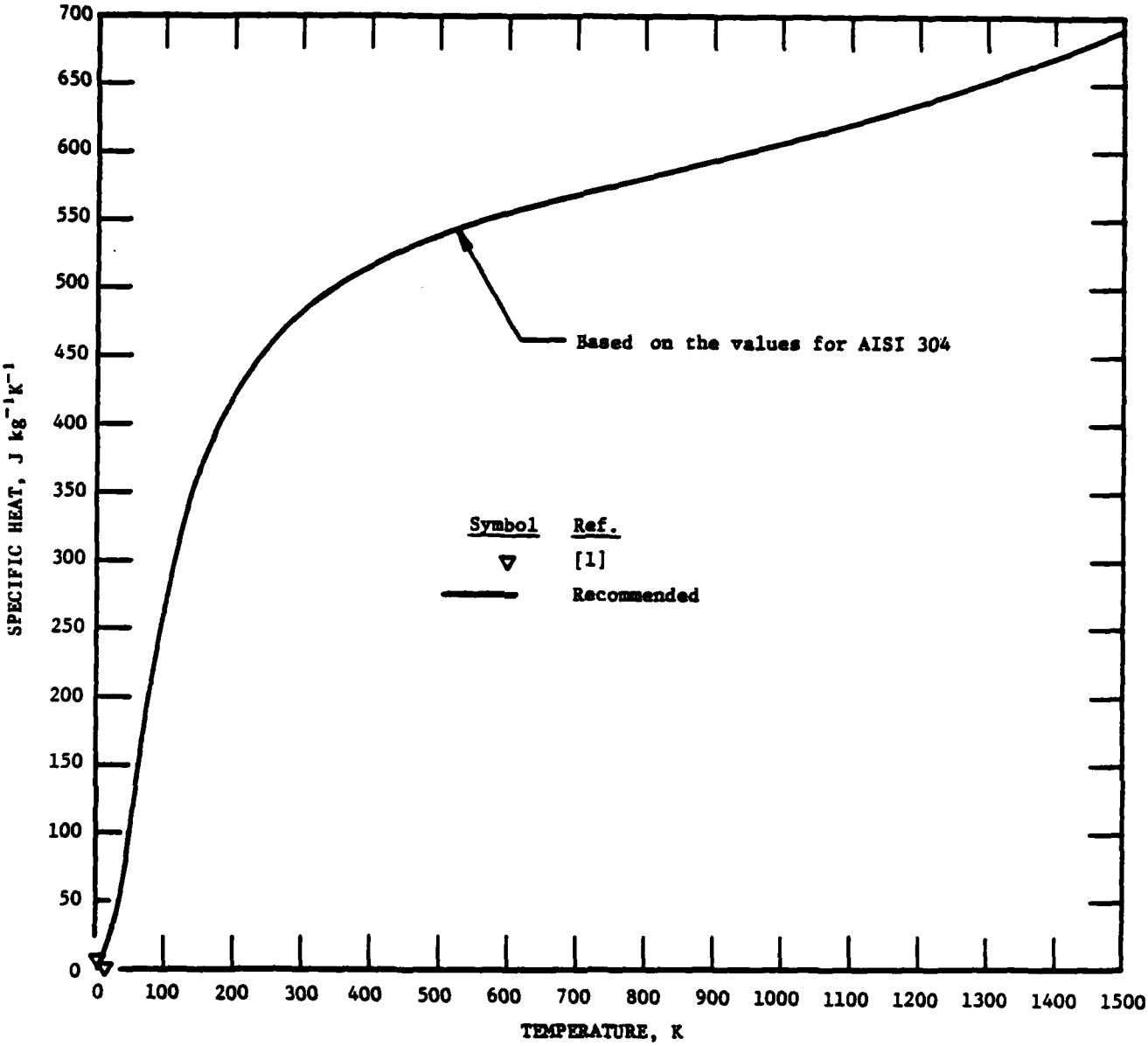

FIGURE 7.2. SPECIFIC HEAT OF 1H18N9 STAINLESS STEEL.

8. ROMANIAN STAINLESS STEELS

8.1. 7TC170 STAINLESS STEEL

The composition of 7TC170 stainless steel is 18.0% Cr, 0.8% Si, 0.8% Ti, 0.7% Mn, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 430 stainless steel [1]. The composition of 7TC170 stainless steel is somewhat similar to that of AISI 430. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 8.1. RECOMMENDED SPECIFIC HEAT OF 7TC170 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	212	900	921
150	322	950	1088
200	384	1000	880
250	428	1050	758
273	440	1100	706
293	451	1200	665
300	455	1300	665
350	497	1400	682
400	497	1500	710
450	517		
500	538		
600	585		
700	644		
800	730		
850	802		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels. Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

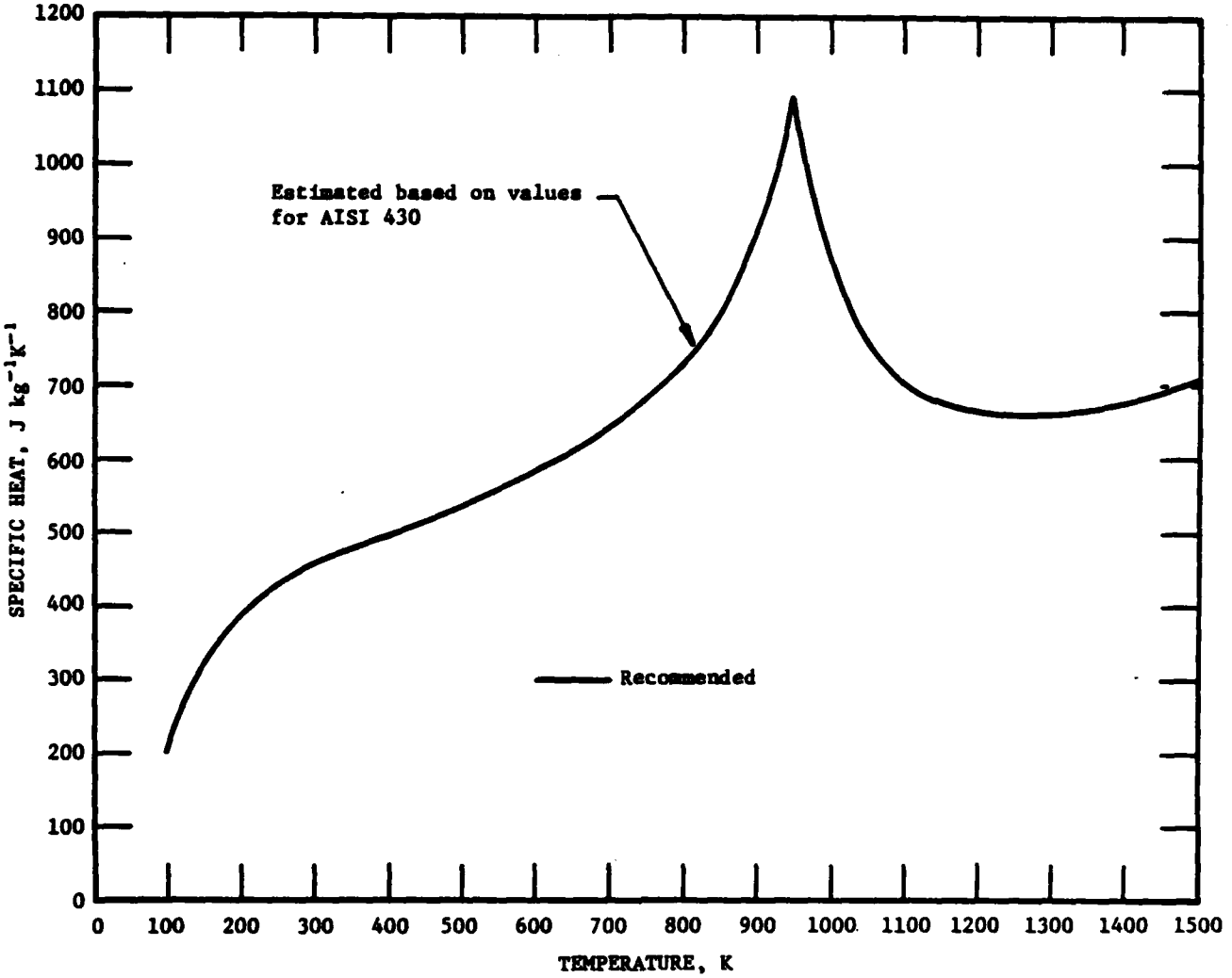

FIGURE 8.1. SPECIFIC HEAT OF 7TC170 STAINLESS STEEL.

9. SWEDISH STAINLESS STEELS

9.1. 3R 12HV STAINLESS STEEL

The composition of 3R 12HV stainless steel is 18.5% Cr, 11.0% Ni, 0.030% C, 0.02% P, 0.015% S, and balance Fe. There are no experimental data sets available for the specific heat of this steel. The recommended values for the specific heat are based on those recommended for AISI 304 stainless steel [1]. The composition of 3R 12HV stainless steel is very close to that of AISI 304. The uncertainty in the recommended values is estimated to be within ±5%.

TABLE 9.1. RECOMMENDED SPECIFIC HEAT OF 3R 12HV STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p	T	c_p
100	268	1000	609
150	370	1100	623
200	423	1200	637
250	457	1300	652
273	468	1400	668
293	478	1500	686
300	481		
350	499		
400	515		
450	527		
500	538		
600	554		
700	569		
800	581		
900	595		

REFERENCE

1. Touloukian, Y.S. and Ho, C.Y. (Editors), Properties of Stainless Steels, Vol. IV-1 of McGraw-Hill/CINDAS Data Series on Material Properties, McGraw-Hill Book Co., New York, NY, in preparation.

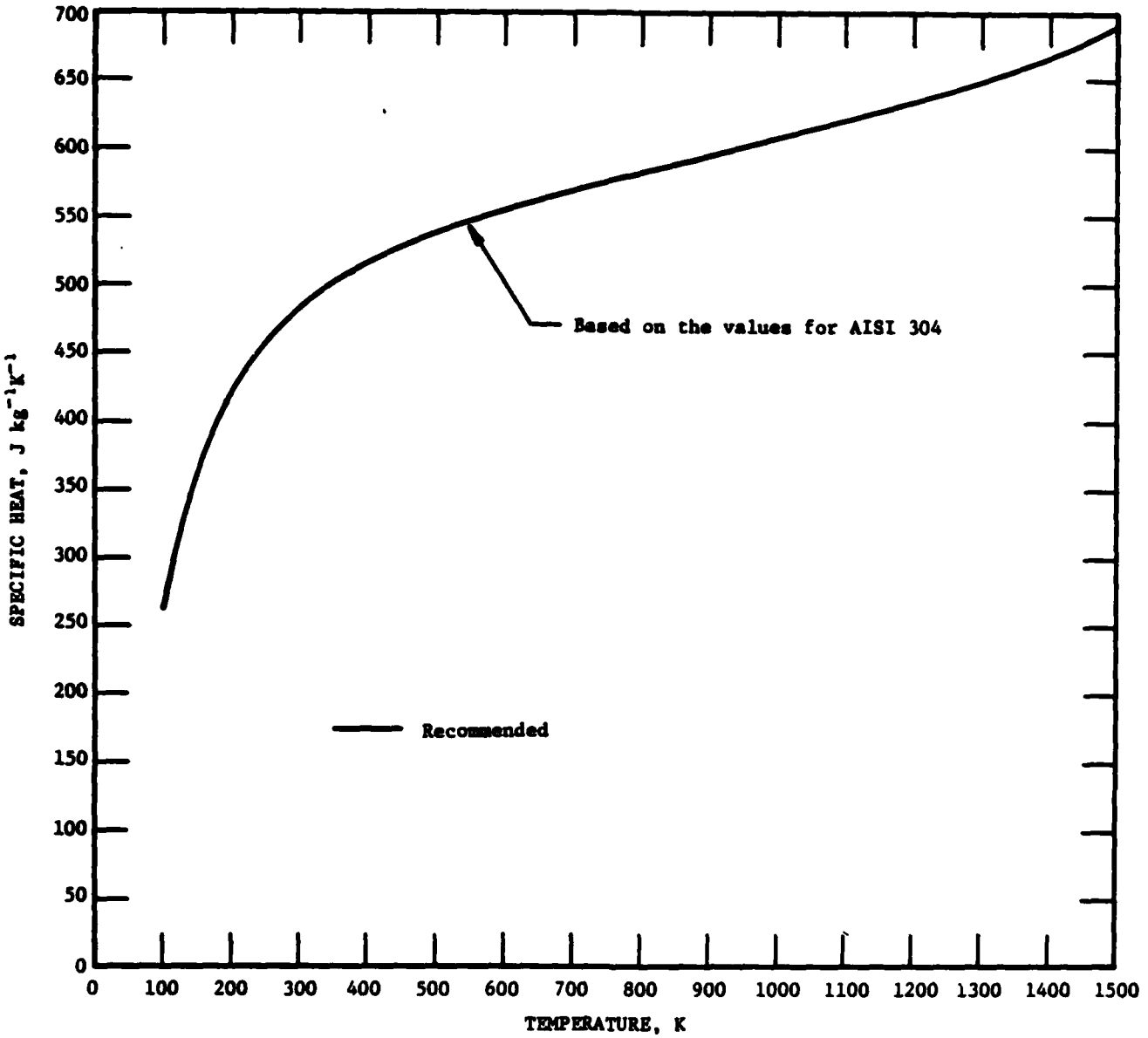

FIGURE 9.1. SPECIFIC HEAT OF 3R 12HV STAINLESS STEEL.

9.2. SANICRO 30 STAINLESS STEEL

The nominal composition of Sanicro 30 stainless steel is 21.8–22.0% Cr, 33.9–34.3% Ni, 0.013–0.021% C, 0.48–0.56% Si, 0.56–0.61% Mn, 0.007–0.010% P, 0.003% S, 0.49–0.58% Ti, 0.01% Cu, 0.28% Al, and balance Fe. The recommended values for the specific heat of this steel are based on the data of Taylor (TPRL) reported by Price [1]. The data of Peggs also reported by Price [1] are lower than the recommended values. The uncertainty in the recommended values is estimated to be within ±3%.

TABLE 9.2. RECOMMENDED SPECIFIC HEAT OF SANICRO 30 STAINLESS STEEL

[Temperature, T, K; Specific Heat, c_p, J $kg^{-1}K^{-1}$]

T	c_p
293	452
300	458
350	491
400	507
450	513
500	515
550	519
600	522
650	531
700	549
800	590

REFERENCE

1. Price, R.G., Atomic Energy of Canada, Ltd. Rept. TSVI-344, 45 pp., 1976.

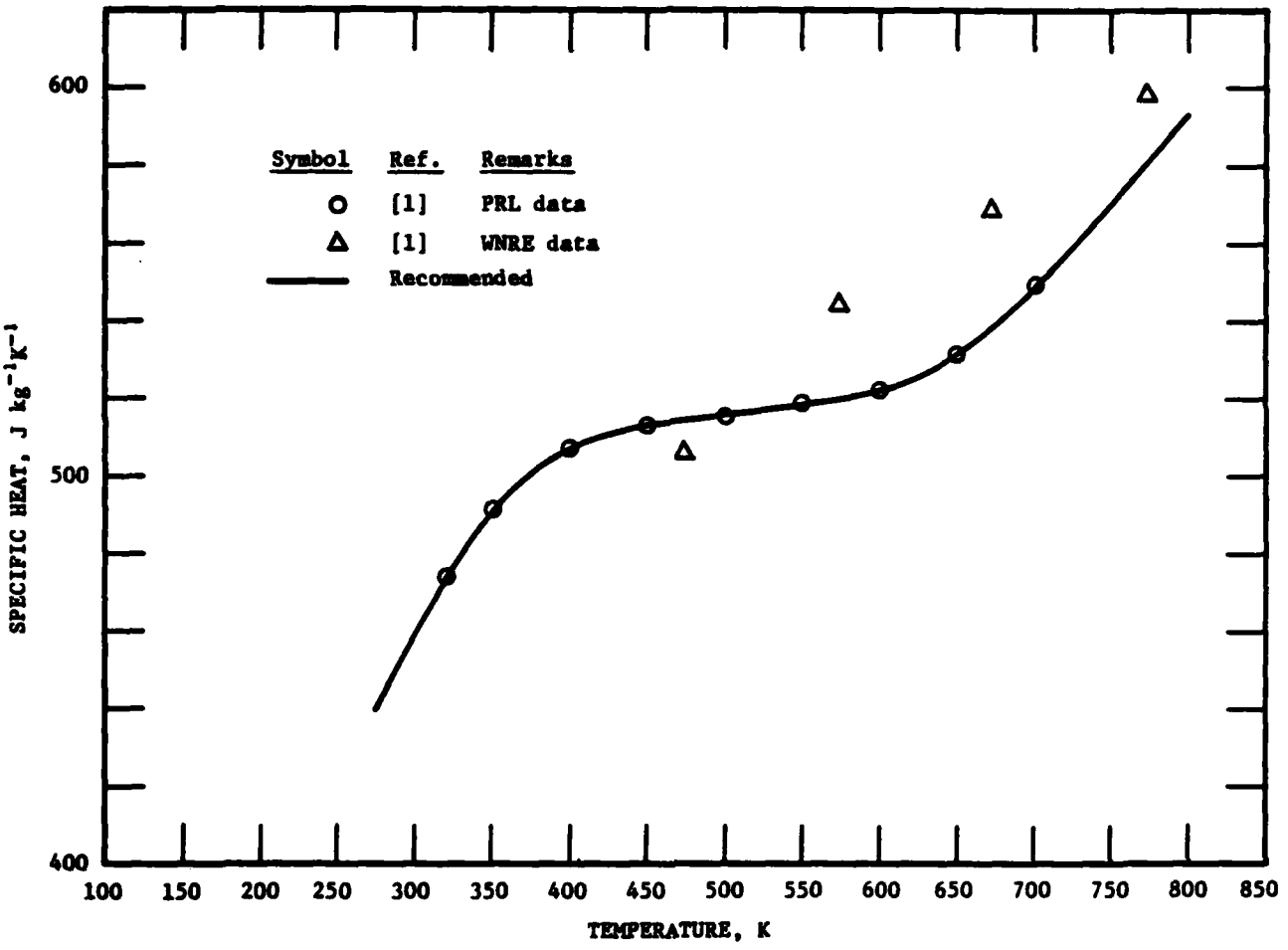

FIGURE 9.2. SPECIFIC HEAT OF SANICRO 30 STAINLESS STEEL.

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